

PLAIN AND FANCY
BRICKWORK

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PLAIN AND FANCY BRICKWORK

COMMON BRICKWORK

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FACE AND ORNAMENTAL BRICKWORK

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PREFACE

Plain and Fancy Brickwork consists of two parts, Common Brickwork and Face and Ornamental Brickwork.

The first part or common brickwork treats of the manufacture and classification of common brick, also of the sizes, colors and weight. Brickwork, or the construction in which brick is used, is then discussed, the subjects considered being the strength, measurements, and numbers of brick that will be required. The tools used in laying brick are next described, also the methods used in laying brick, erecting scaffolds, etc.

Various kinds of brick walls such as solid, hollow, party, fire-walls, enclosures, and veneered walls are described. The subject of bond in brickwork is carefully discussed and illustrated so that the reader will obtain an excellent idea of the methods of bonding brickwork.

Bonding walls at angles, openings in walls, brick arches, fire stopping, backing up, also use of hangers for wooden beams and of anchoring wood and steel beams to walls are described and clearly illustrated.

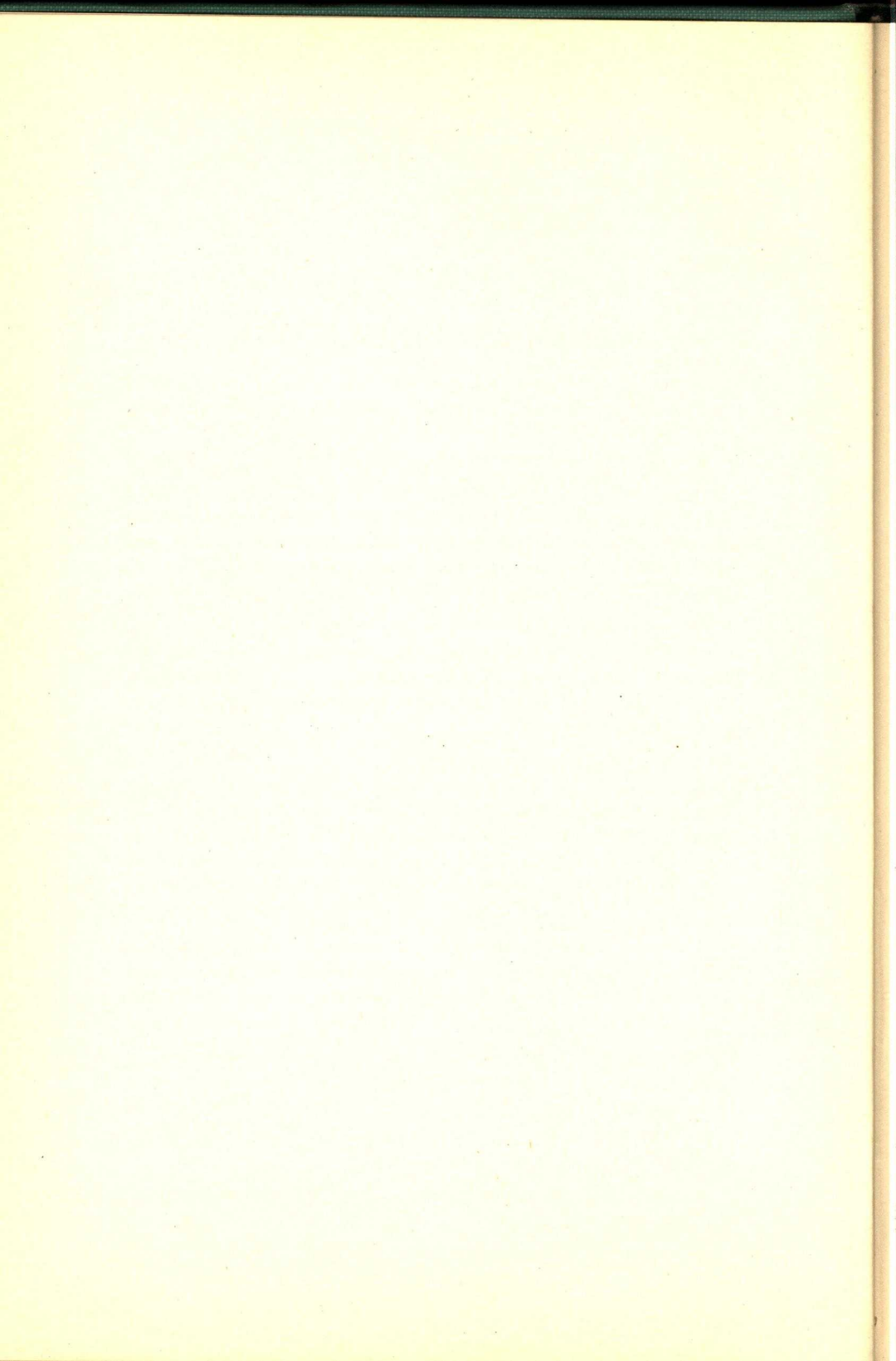
The important subject of chimney and fireplace construction is discussed and amply illustrated.

The second part of the book treats of Face Brick and its use. A short historical review is first given, then a full description of the various kinds of face brick available for use. The sizes, textures, colors, etc., of face brick are discussed and several colored plates are introduced showing the effects of bricks of various colors and textures in connection with mortar joints of different widths and with different-colored mortars.

The various bonds that are used on the face of the wall are shown, also numerous patterns in which face brick may be laid. Examples of buildings in which patterns in face brick have been successfully used are also shown.

This book should be of use to the mechanic as well as to those wishing to build as there are numerous suggestions that will be of great interest to those interested in building.

W. S. LOWNDES



COMMON BRICKWORK

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BRICK

1. Definition and Description.—Bricks may be defined as solid building units made of burned clay. They are comparatively small in size, therefore easily handled, and being already burned are extensively used in buildings that are intended to be fire-resistive and in other forms of construction that are permanent in character. When referred to in the mass, or as a building material, they are called *brick*.

Brick can be made cheaply and, when hard burned and laid in good mortar, is one of the most durable building materials in use. Common brick can be used to form solid, or even hollow, walls when desired, or can be used to back up a wall that is faced with a most costly material, such as face brick, terra cotta or stone. While common bricks are manufactured mainly with a view to service, they may be used for facing walls. In many localities the clays or shales used in making common brick produce, when burned, a variety of colors and textures resulting in the most pleasing effects as laid in the wall. These effects may be obtained by using the bricks as they come from the kiln without selecting, or by selecting and grading the bricks. The possibilities of artistic treatment of wall surfaces are not even limited by the range of color or texture. With the use of any good hard brick a variation in color effect and texture of wall surface may be obtained by varying the character of the bond and the size and color of the mortar joint. This use of certain kinds of common brick is also discussed and illustrated in the Section on *Face and Ornamental Brickwork*.

MANUFACTURE OF BRICK

2. Ingredients.—The principal material used in making brick is clay, where naturally suitable as it comes from the clay bank, or a combination of clay and sand, called silicate of alumina. Suitable basic materials of this nature are found throughout almost every state in this country. Brickyards abound in nearly every locality and in the making of brick and other clay products a practically inexhaustible material is drawn upon. This material, as found in nature, generally contains small quantities of other chemical substances such as iron, magnesia, lime, potash, etc. Each of these substances has a particular effect upon the color, hardness, and durability of the brick, and by the judicious use of these substances, either alone or in combination, certain characteristics in the finished brick can be obtained. Such combinations are often made by mixing together two or more clays containing different chemical substances.

HAND-MADE BRICKS

3. In the process of making clay bricks by hand, the clay is mixed with water and worked to a plastic state in a *pug mill*, and then the soft plastic clay is pressed into molds by hand. The molds are sometimes dipped into water, just before being filled with the clay, to prevent the mud from sticking to them when the mold is removed. Bricks molded in these wet forms are known as *slop bricks* and also as *water-struck bricks*. Sand is sometimes sprinkled into the molds to prevent the clay sticking, or to produce a sand-finished texture on the faces as laid, and the bricks from sanded molds are called *sanded bricks*. After the bricks are shaped in the mold, they are removed and laid in the sun, or in a drying house, for 3 or 4 days, after which they are stacked in kilns and burned.

The hand method of making bricks and the sun method of drying, being very slow and laborious, have been almost entirely displaced by more economical and expeditious ones in which the work is done by machinery.

MACHINE-MADE BRICKS

4. Nearly all bricks are now made by machinery. Where they are made on a large scale, steam shovels frequently are used for excavating the clay, and conveyors carry the raw clay to the mill and also convey the molded bricks to the drying sheds and the kilns.

Machine-made bricks are usually formed by one of three methods known as the soft-mud, the stiff-mud, and the dry-clay process.

5. **Soft-Mud Process.**—In the **soft-mud process**, the clay is soaked in water until soft. It is then thoroughly mixed by machinery, and pressed into molds by a plunger. The bricks are then dried and burned.

6. **Stiff-Mud Process.**—In the **stiff-mud process**, the clay is first thoroughly ground, and just enough water is added to make a stiff mud. After this mud is mixed in a pug mill, it is placed in a machine having a die the exact size of the brick required. The opening in this die is made the size of either the end or the side of a brick. The machine forces a continuous bar of clay through this die, and as it emerges it is automatically cut into bricks, which are then taken to the drying yard. The bricks that are cut on the ends are called *end cut*. Those cut on the sides are known as *side cut*. The soft bricks are placed in rows in a yard covered by a rough shed, with open sides, where they are sun or air dried for a considerable length of time or are run on special trucks into drying houses and are dried in from 4 to 8 days by steam or waste heat from the kilns. When properly dried they are placed in the kiln and burned.

7. **Dry-Clay Process.**—The process often employed in the best work is the **dry-clay process**. In this method of manufacturing brick, the clay is used just as it comes from the bank, and is apparently perfectly dry. It contains, however, about from 7 to 10 per cent. of moisture. The clay is filled loosely into molds of the same width and length as a brick, but deeper than the required thickness of the brick. A plunger

that exactly fits the mold is then forced in under heavy pressure and compresses the clay to the size of the brick desired. The bricks are then removed to the kiln and fired.

Molded bricks are made in the same way, the difference being that the mold is made to give the shape of the brick required.

Whenever the term *pressed brick* is used, it should mean brick made by the dry process. There are many so-called *dressed* or *face bricks*, however, that are made by recompressing soft-mud bricks.

DRYING AND BURNING OF BRICK

8. Bricks must be dried before being burned. Soft-mud bricks naturally require a longer time to dry than stiff-mud bricks. Having been properly dried, they are placed in kilns and burned. The types of kilns used are the up-draft, the down-draft, and the continuous kilns. The details of these kilns and their operation will not be described here. The important thing is that the bricks shall be well burned and satisfactory in shape and color. It might be said, however, that bricks burned in the modern forms of kilns are more uniform in color, shape, and hardness than those made in the old-fashioned kiln.

CLASSIFICATION OF BRICK

9. **Common Brick.**—The term *common brick* includes all brick made for structural purposes and produced without artificial scoring or marking of the exposed surface to give especial texture.

The distinguishing line between common and face brick in modern practice seems to be the special mixing of ingredients and the artificial coloring and scoring or rough texture, or the repressing process of the smooth brick, and the fact that face brick are graded, handled, and packed with great care.

Many face-brick plants and nearly all paving plants produce a proportion of common brick. Face brick *culls* are sold as *commons*.

The terms applied to grades of common brick vary in different parts of the country. In some places the bricks, although not alike, are sold without selection or grading. In other places the kiln is graded as *front* brick and *back* brick, the front being hardest burned. In others there are *hard* and *kiln run* brick.

In the overburned brick called *clinkers*, the clay fuses and causes irregular shapes and sizes. These bricks are usually extremely hard and very durable. Clinker bricks are in favor with many architects for ornamental purposes and should be laid with proper bond, size and kind of joint and color of the mortar.

Common bricks burned in the old-style up-draft kilns are classified according to their position in the kiln, which affects the amount of heat to which they are subjected. In some localities three grades of brick are produced in these kilns, namely, *arch* or *clinker* brick; *red*, or *well-burned*, brick; and *soft*, or *salmon*, brick. In other localities four grades are produced, namely: *rough-hard* (corresponding to arch brick), *straight-hard*, *stretcher*, and *salmon*.

Arch, or clinker, brick is the name applied to the bricks that have been nearest the fire and are consequently overburned.

Red, well-burned, or straight-hard, brick constitutes the hardest and the largest part of the product of the kiln; *stretcher* brick being a selection of the most uniform of these.

Salmon brick is the name applied to those that have been farthest from the fire and are consequently underburned and soft. In many localities these are used for interior, or unexposed walls, party walls and others not carrying heavy loads.

In certain localities the clay is of such a composition that the best brick from the kiln is of a salmon color and such brick should not be confused with the salmon brick just described.

The American Society for Testing Materials has adopted names for common brick as follows: *vitified brick*, *hard brick*, *medium brick*, and *soft brick*. These grades conform in general to the classification just mentioned.

10. Face Brick.—Face bricks are made of specially selected materials so that the brick shall be of certain desired

colors, and with the faces scored or of a rough texture. These bricks are described in the *Section Face and Ornamental Brickwork*. Common bricks are often made or selected for color, *fire-flashed* effects and shape, and used for facing brick walls.

11. Pressed Brick.—Pressed bricks are those that have been pressed in a machine, and are usually hard, smooth, and have sharp corners and true shapes. They are used as face brick.

12. Firebrick.—Firebricks are made from fireclay and are used for lining furnaces, lime kilns, fireplaces, and chimneys in factories. They are usually somewhat larger than ordinary building bricks, and should be of homogeneous composition and texture, uniform in size, of a regular shape, easily cut, and not fusible. The best firebricks are hand-molded.

13. Paving Brick.—Paving bricks are usually made by the stiff-mud process, being repressed to give them a better shape, and are composed of about three parts of shale clay to one part of fireclay. They are burned at a high temperature to the point of vitrification, that is, to a heat at which they begin to fuse or melt. These bricks have a high crushing strength and absorb very little moisture. They are used principally for paving driveways, and occasionally for paving flat roofs on fireproof buildings.

14. Hollow Brick.—Hollow bricks are made of a stiff-mud mixture by machinery, as holes must be formed in the body of the brick. Hollow bricks are now being made more generally by manufacturers of terra-cotta tile, as the material and machinery used in manufacturing tile is better adapted to making hollow brick than is the machinery used in brick making.

15. Sand, or Sand-Lime, Brick.—The composition of **sand brick** is usually 95 per cent. of sand and 5 per cent. of slaked lime. This mixture is forced into molds under a very high pressure, and the bricks are removed from the molds and heated with superheated steam. These bricks can be made in

many colors by artificial means, and can thus be used to effect the most pronounced designs. Sand bricks are manufactured by many firms in the United States, some of which make a very good dense brick, while others make an inferior sandy article.

SIZE, WEIGHT, AND QUALITY OF BRICKS

16. Size and Weight.—There is no universally accepted standard size of brick in America, although the American Society for Testing Materials and the Common Brick Manufacturers Association of America have adopted as a standard size for common brick, 8 in. $\times$ $3\frac{3}{4}$ in. $\times$ $2\frac{1}{4}$ in. The dimensions of brick vary with the locality and also with the maker. Bricks taken from the same kiln will vary in size due to the amount of heat to which they have been subjected.

In the New England States, the average size of a common brick is about $7\frac{3}{4}$ in. $\times$ $3\frac{3}{4}$ in. $\times$ $2\frac{1}{4}$ in.; New York and New Jersey bricks will run about 8 in. $\times$ 4 in. $\times$ $2\frac{1}{2}$ in.; and the walls laid in them will measure about 8, 12, 16, and 20 inches in thickness for 1, $1\frac{1}{2}$, 2, and $2\frac{1}{2}$ bricks. Some of the western common bricks measure $8\frac{1}{2}$ in. $\times$ $4\frac{1}{8}$ in. $\times$ $2\frac{1}{2}$ in., and the thickness of the walls measures about 9, 13, 18, and 22 inches for thicknesses of 1, $1\frac{1}{2}$, 2, and $2\frac{1}{2}$ bricks. On the seacoast of some of the Southern States, the bricks will average 9 in. $\times$ $4\frac{1}{2}$ in. $\times$ 3 in.

The weight of bricks varies considerably with the material used in their manufacture and also with their size. Common bricks will average about $4\frac{1}{2}$ pounds each.

17. Quality.—All bricks should be of uniform dimensions, free from twists, cracks, and pebbles, and should have sharp corners. The bricks should be well burned but not vitrified lest they become brittle. When two bricks are struck together, they should emit a metallic ring. A good brick will not absorb over 10 per cent. of its weight of water if allowed to soak for 24 hours.

COLOR OF BRICK

18. The color of brick is usually not considered of any importance in common brickwork, but as walls of this kind of brick are sometimes exposed to view, the selection of bricks as to color and shade may be desired and consequently the architect's specifications should clearly state if this selection is required.

The color of common bricks depends largely upon the kind of clay used in making them and the temperature attained in the kiln during the burning.

Bricks burned in down-draft kilns are more uniformly burned and are consequently of a more uniform red color.

BRICKWORK

GENERAL DISCUSSION

19. **Definition.**—By the term *brickwork* is meant any construction made of bricks laid up in mortar. It can readily be seen that the strength of brickwork is not dependent on the strength of the brick alone. Other factors influence this, such as the strength of the mortar and the method of laying up and bonding the brick. Therefore, the value of brickwork, so far as strength and stability is concerned, may be decreased by the use of inferior mortar or by being laid by a bricklayer who does not understand his trade.

20. **Importance of Mortar.**—In laying bricks, it is customary to bed them in mortar. The mortar serves several purposes. It tends to make the wall waterproof and air-proof under ordinary conditions; it forms a cushion to take up the irregularities in the bricks and thus distributes the pressure evenly, and it bonds the whole wall into one solid mass, which increases its strength and stability.

Mortar for brickwork may be made of various combinations. It may be formed either of slaked or hydrated lime and sand in

proper proportions, or of lime and sand mixed with a small quantity of cement. It may also be made of cement and sand, or cement and sand to which a small percentage of slaked or hydrated lime is added. Lime mortar is, however, to be avoided in work coming in contact with earth or subject to dampness. Mortars of various kinds and qualities are more fully discussed in the Section *Limes, Cements, and Mortars*.

21. Size of Mortar Joints.—With soft-mud or stiff-mud bricks there are likely to be some irregularities which make necessary larger mortar joints than are generally required for pressed brick. For this reason common bricks are generally laid in mortar about $\frac{1}{4}$ inch to $\frac{1}{2}$ inch in thickness.

If a wall is faced with common bricks or bricks that have a rough texture, the joints in the facing are sometimes made as much as $\frac{3}{4}$ inch in thickness and the backing is adjusted either by additional courses of bricks or thicker mortar joints than usual to bring the two kinds of brickwork to the same level, so that they can be bonded together at approximately every six or eight courses in the height of the wall.

STRENGTH OF BRICKWORK

22. Bricks for ordinary requirements are seldom tested for crushing strength, as the masonry formed of well-burned brick laid in good cement mortar will carry all ordinary loads. Bricks should not fail, however, under a crushing load of less than 1,800 pounds per square inch.

The strength of brickwork is influenced by the quality of the brick and the mortar of which it is composed. In cases where the brick is harder than the mortar, the latter is the factor that determines the strength of the brickwork. For this reason the load that may be placed upon brickwork varies with the kind of mortar that is used in its construction. These allowable loads are stated in the building laws in various localities. Local building laws should therefore be consulted when determining the loads on walls of buildings that come under the jurisdiction of such laws. Where no such laws exist, the Building Code

recommended by the National Board of Fire Underwriters is authority for the statement that 111 pounds per square inch may be taken as a safe load for masonry formed of bricks laid in good lime mortar; 208 pounds per square inch for lime and Portland cement mortar; 208 pounds for natural cement mortar and 250 pounds for Portland cement mortar in the proportion of three parts of sand to one part of cement, of which not more than 15 per cent. of the Portland cement by volume may be replaced by an equal amount of dry hydrated lime.

MEASUREMENT OF BRICKWORK

23. The usual method of measuring brickwork is by the thousand bricks laid in the wall. A customary method of estimating the number of bricks in a piece of brickwork is first to determine the entire area of the face of the wall in square feet, measurements being taken on the outside of the wall, and not on the inside. This is done to offset the extra labor that is required in laying up the corners or angles. The number of bricks is computed approximately from these areas, using the number of bricks to the square foot as shown in Table I. Thus, when using a brick $8'' \times 3\frac{3}{4}'' \times 2\frac{1}{4}''$, laid with a $\frac{1}{2}$ -inch joint, there would be 6.17, or $6\frac{1}{6}$, bricks per square foot for a wall 4 or $4\frac{1}{2}$ inches, or 1 brick, thick; $12\frac{1}{3}$ bricks for a wall 8 or 9 inches, or 2 bricks, thick; $18\frac{1}{2}$ bricks for a wall 12 or 13 inches, or 3 bricks, thick; $24\frac{2}{3}$ bricks for a wall 16 or 17 inches, or 4 bricks, thick, and so on, $6\frac{1}{6}$ bricks per square foot being added for every additional brick in the thickness of the wall. The estimate is then based on the number of thousands of brick, at a suitable price per thousand, including labor and mortar. For example, a wall 24 feet long, 12 feet high and 20 inches, or 5 bricks, thick, would contain $24 \times 12 = 288$ square feet 5 bricks thick. At $6\frac{1}{6}$ bricks this would be $288 \times 5 \times 6\frac{1}{6} = 8,880$ brick.

24. The window and door openings in brick walls should always be deducted. While formerly it was in some places the custom not to deduct openings in estimating brickwork, modern

methods adopted by all careful and efficient contractors include the figuring out with exactness the number of bricks required, as above indicated. This applies with force to the quantity of mortar necessitated for the brick. If walls are built hollow a deduction is likewise made for absence of brick and mortar therein. The same is true of all flues in chimneys, the saving in brick alone paying for the cost of the flue lining which

TABLE I
NUMBER OF BRICKS TO THE SURFACE FOOT FOR
DIFFERENT SIZES OF BRICKS WITH JOINTS
OF VARIOUS THICKNESSES

Size of Brick Inches	Thickness of Joint					
	$\frac{3}{16}$	$\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{2}$
	Number of Bricks					
$7\frac{1}{2} \times 3\frac{3}{4} \times 2\frac{3}{4}$	7.31	7.08	6.86	6.65	6.45	6.26
$7\frac{3}{4} \times 3\frac{3}{4} \times 2\frac{1}{4}$	7.44	7.20	6.97	6.75	6.55	6.35
$8 \times 3\frac{3}{4} \times 2\frac{1}{4}$ *	7.22	6.98	6.76	6.55	6.35	6.17
$8 \times 4 \times 2\frac{1}{2}$	6.55	6.35	6.16	5.98	5.81	5.65
$8\frac{1}{4} \times 3\frac{3}{4} \times 2\frac{1}{4}$	7.00	6.78	6.56	6.36	6.17	5.98
$8\frac{1}{4} \times 4 \times 2\frac{1}{4}$	7.00	6.78	6.56	6.36	6.17	5.98
$8\frac{1}{2} \times 4\frac{1}{8} \times 2\frac{3}{8}$	6.47	6.27	6.08	5.90	5.73	5.57
$8\frac{1}{2} \times 4\frac{1}{8} \times 2\frac{1}{2}$	6.17	5.99	5.81	5.64	5.49	5.33
$9 \times 4\frac{1}{2} \times 3$	4.92	4.79	4.67	4.55	4.45	4.33

*Standard size adopted by American Society for Testing Materials and The Common Brick Manufacturers' Association of America.

should invariably be used, except in the case of thick walls as mentioned in the articles on *Chimneys and Fireplaces*.

25. In Table I is given the number of bricks required for 1 square foot of face of a wall one brick thick—that is, having a thickness equal to the width of a brick—when laid with mortar joints of different thicknesses and bricks of various sizes.

26. This table will be found useful in estimating the number of bricks in any wall. To find the number of bricks per

square foot of face of a wall of any thickness, find in the table the number of bricks per square foot of face of wall for the size of brick and thickness of joint that are to be used and multiply this number by the number of bricks in thickness of the wall. The result will be the number of bricks per square foot of face of the wall in question.

27. For example, according to the table, if bricks $8\frac{1}{4}$ in. $\times$ 4 in. $\times$ $2\frac{1}{4}$ in. in size are to be used, with mortar joints $\frac{3}{8}$ inch in thickness, the number of bricks per square foot of the face of the wall will be 6.36, if the wall is one brick in thickness; if the wall is two bricks in thickness, it will contain 12.72 bricks; if three bricks thick, 19.08 bricks; if four bricks thick, 25.44 bricks.

It will be observed in Table I that the two $8\frac{1}{4}$ -inch bricks show the same number of bricks per surface foot. The reason for this is that the $8\frac{1}{4}$ - and $2\frac{1}{4}$ -inch dimensions are the only ones that show on the face of the wall. The $3\frac{3}{4}$ - and 4-inch dimensions affect only the thickness of the wall.

28. Labor Required.—The amount of labor required for laying brick is a very uncertain quantity. An average man may lay from 750 to 1,000 bricks per day where the work is somewhat broken up and there are openings, or where the walls are thin. On thick straight walls with few openings a man may lay 1,200 to 1,500 bricks per day.

BRICKLAYING

TOOLS AND METHODS

29. Tools Used in Bricklaying.—The tools that are required in building brickwork are a two-foot rule, a long and a short plumb-rule, a level, a large steel trowel, a small steel trowel, a cutting-out hammer, a bricklayer's set, a brick jointer, wooden gauges for measuring bricks, a mason's linen line, chalk, a pencil, and leather protectors for the hand when laying wet or rough-cut bricks.

30. The **long plumb-rule**, or **plumb**, should be from 3 feet 6 inches to 4 feet long, about $3\frac{3}{4}$ inches wide, and about

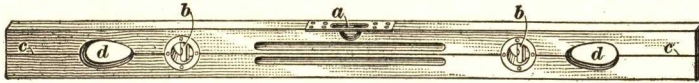


FIG. 1

$1\frac{1}{8}$ inches thick, with two plumb-glasses at opposite ends, like those shown at *b* in Fig. 1.

The **short plumb-rule**, or **plumb**, should be from 16 in. to 18 in. long, with one plumb-glass like that shown at *b* in Fig. 1 and one level glass, as at *a* in Fig. 1.

31. In Fig. 1 is shown what is known as a combination plumb-rule and level. It is used in a horizontal position as a level and the level glass *a* indicates when the level is exactly horizontal. It is used as a plumb-rule by holding one edge against the work to be plumbed and observing the level glasses *b*. A plumb-bob may be suspended from either end of the instrument so that it will hang in one of the openings *d*. The work is then tested by holding one edge of the plumb-rule against it and moving the instrument until the plumb-line coincides with the center line on the face of the plumb; then if the work does not coincide with the edge of the rule it is out of plumb or not perpendicular.

32. A simple form of **plumb-rule**, shown in Fig. 2, is made of a piece of board $\frac{1}{2}$ inch thick and 3 or 4 inches in width. The edges of the board and the line *d* are parallel. A plumb-bob *b* is suspended on a cord fastened through the notches at the top of the rule and hangs in the opening *c*. When the edge of the rule is placed against a vertical surface and the line coincides with the middle line *d* on the rule the surface is plumb. A plumb-rule of this description may be easily made and is very accurate but is not so convenient as a rule with level glasses.

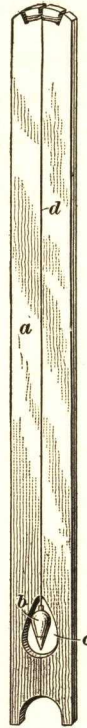


FIG. 2

The advantage of the leveling glasses in the plumb-rule is that the wind does not interfere with its action. In the case

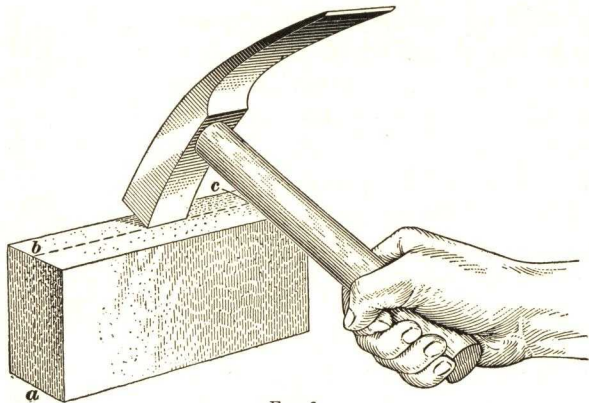


FIG. 3

of a plumb-bob suspended from a cord, even a small breeze causes motion of the bob, which interferes with its usefulness.

33. The principal tool used by a brickmason is the **trowel**, the form and use of which is illustrated further on in Figs. 8, 9, 10, and 11. These trowels are made from $9\frac{1}{2}$ inches to

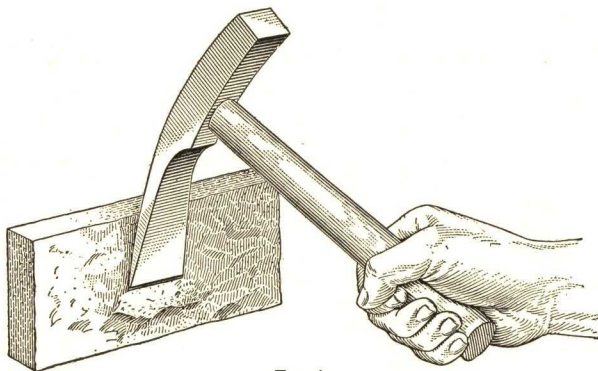


FIG. 4

11 inches in length. Pointing trowels are made from 4 to 7 inches in length.

34. A **cutting-out hammer** should weigh not less than $3\frac{3}{4}$ pounds and not more than 4 pounds, exclusive of the handle. There are many types of hammers that can be used for cutting out, but the one shown in Fig. 3 will enable a first-class man to do the most work with the least fatigue. In this figure is also shown the method of splitting a brick by means of the hammer. A line *a b c* is formed around the brick by means of light blows of the hammer and then a sharp blow is given which causes the brick to split at approximately this line. Any rough places on the split faces of the brick are trimmed off by the blade of the hammer, which is called the *peen*, or *pean*, as shown in Fig. 4.

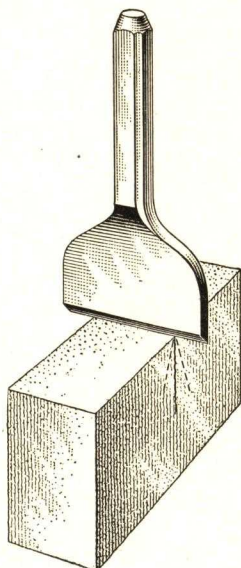


FIG. 5

35. A **brick set**, shown in Fig. 5, is a chisel with a broad cutting edge. It is used when it is necessary to make a cut having straight edges, so that the cut portion may show on the face of the wall, or to make plumb joints with adjacent bricks.

36. A **jointer**, shown in Fig. 6, is a tool that is used to form a true, even, and smooth surface on the face of the mortar between the bricks. Except where common bricks are exposed for effect this tool is not generally used, as the joints of mortar

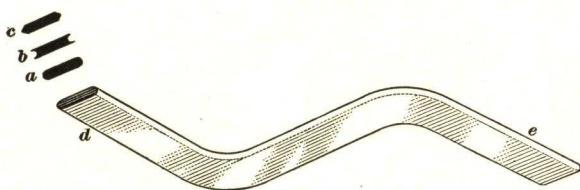
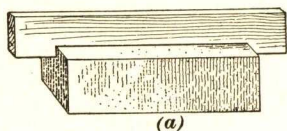


FIG. 6

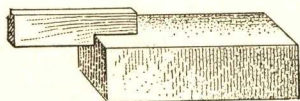
are struck with the trowel as the work progresses; but a brick-mason should possess one for use in connection with such face

effects or face-brick work. Such a tool, at the very best, gets dull and loses its shape quickly, owing to the wearing action of the sand in the mortar, consequently it should be made of the hardest tempered steel that is obtainable. At *a*, *b*, and *c*, Fig. 6, are shown sections through jointers of different kinds. The edges of these jointers are curved or pointed so as to give different profiles to the mortar. The ends *d* and *e* of the jointer may have different sections, so as to be useful for striking two shapes of joints.

37. Wooden gauges, shown in Fig. 7 (*a*), are used to test the lengths of bricks when they are to be selected of a uniform size. The gauge shown in (*b*) is used when it is desired



(a)



(b)

FIG. 7

to cut bricks into smaller sections of uniform length. These tools are used for gauging face brick, but may frequently be used for common brick used in facing walls.

38. The line, chalk, and pencil are familiar but indispensable implements. Pieces of leather, called *leather protectors*, are used by some mechanics to protect their

hands when they are required to handle a great number of bricks daily.

39. Method of Laying Brick.—In connection with the laying of brick, certain terms are used. When a brick is laid with its length in the direction of the wall, as shown at *a* in Fig. 18, it is termed a *stretcher*; a brick placed crosswise so that its end is exposed in the face of the wall as shown at *b* in Fig. 18, is called a *header*. A *course* of brick may mean one horizontal layer of brick or it may mean one horizontal layer of brick and one horizontal mortar joint.

In America, most bricks are laid in what is known as the *American bond*, which is described later in this Section. This bond consists of a layer, or course, of headers and four or five courses of stretchers, then another course of headers, etc. In building brickwork of this kind it is customary to lay the

courses on the outside of the wall first. As many as five or six courses are laid before the bricks forming the inside of the wall are put in place. These outside courses are laid up plumb and level and serve as guides for the courses on the inside of the wall.

40. The first step in laying the wall is to build a portion at each end and see that these are plumb and that the courses at each end are level with the corresponding courses at the other end.

A mason's **line** is then stretched between these ends to serve as a guide in laying the brick in between. In Fig. 8 is shown a mason's line *c d* and the method of attaching it temporarily to

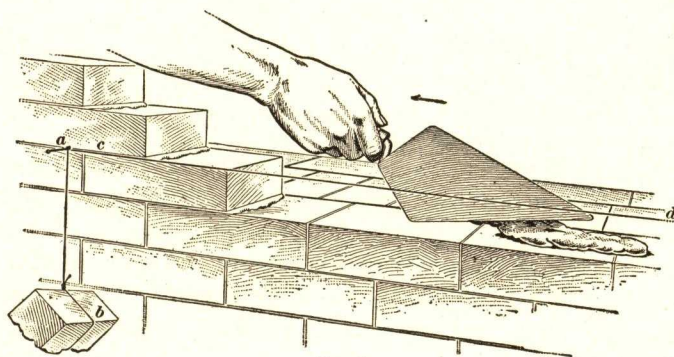


FIG. 8

the wall. This is done by driving a nail *a* into the mortar joint and winding the line around this once or twice. The line is held taut by tying a piece of brick *b* to the end. The line is secured in a similar manner to the corresponding course at the other end of the wall and bricks are laid in between so that their upper edges coincide with the line. By this method the wall is kept plumb and the horizontal joints straight and level.

When the work is interrupted for any length of time, the outer courses should not be higher than the backing, especially where face brick is used, as the mortar joints in the face of the wall will dry out too rapidly and the color of the mortar will appear different from that in other parts of the face of the wall.

41. In Fig. 8 is shown the actual process of laying brick in a 16-inch or 17-inch wall. A trowel with mortar on it is moved

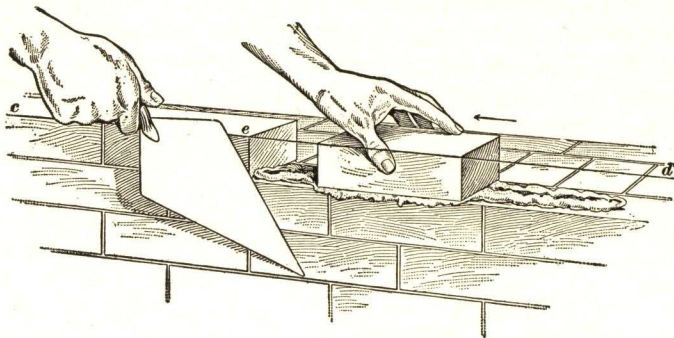


FIG. 9

over the wall in the direction of the arrow and at the same time is tilted so as to allow the mortar to slide off. This distributes the mortar over the outer course of brick in the wall. The mortar is then spread with the point of the trowel, which is drawn through the mortar with a vibrating motion of the hand which causes the mortar to form little ridges as shown in Fig. 9. A brick is then placed on this mortar bed about 3 or 4 inches away from the brick against which it is to be placed, as shown in Fig. 9, and is shoved into place as in Fig. 10. The shoving movement forces a quantity of mortar up into the vertical

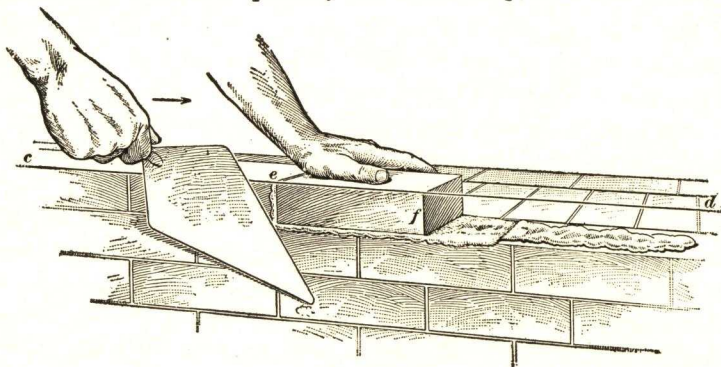


FIG. 10

joint *e*, Figs. 9 and 10, and squeezes out any excess of mortar that may be in the joints.

The upper edge of the brick should coincide with the line *c d*, which is the mason's line previously referred to. If this edge is too high, the brick is tapped down with the handle of the trowel or sometimes with the hammer until it is even with the line. If the top of the brick is below the line, the brick must be taken up and more mortar placed under it.

When the brick has been accurately placed, all the mortar which has been squeezed out while placing the brick and which projects beyond the face of the wall is removed by a stroke of the trowel as indicated in Fig. 10. This surplus mortar adheres

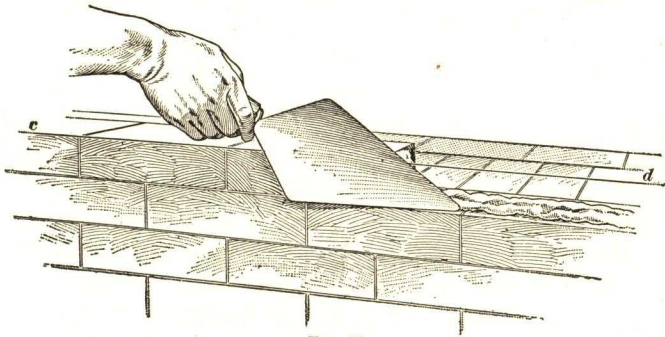


FIG. 11

to the trowel and is scraped off against the vertical edge of the brick as shown in Fig. 11.

42. After five or six courses have been laid on the face of the wall, the joints are all smoothed with a trowel, then the interior of the wall back of these face courses is begun.

The inside course is first laid in the manner described for the face courses and the mortar joints on the inner face of the wall are smoothed with the trowel. A bed of mortar is then placed between this course and the outer course and bricks are placed in the space quite rapidly, as it is not necessary that they be exactly placed. Bricks that are slightly chipped, warped, or that have slight defects are used in the heart of the wall with satisfactory results. Mortar is then filled in between these bricks from the top and another row, or course, is placed on top of the one just finished. Very often the joints in the interior of a brick wall are not completely filled with mortar, and where

the wall does not bear a heavy load this kind of work may be sufficient. In the case of piers and portions of wall that support great loads, it is necessary that all the interior joints in the wall be well filled with mortar.

43. Frequently, instead of laying the bricks on the outside of the wall with a shoved joint, as illustrated in Fig. 9, the bricks are laid right in place, as shown in Fig. 12, with only a small amount of mortar between their ends, such as has been scraped off the trowel. This joint should be afterwards filled by throwing mortar into the top of it from the trowel.

44. Laying Brick in Severe Weather.—When brickwork is erected in freezing weather, all the materials, as far as

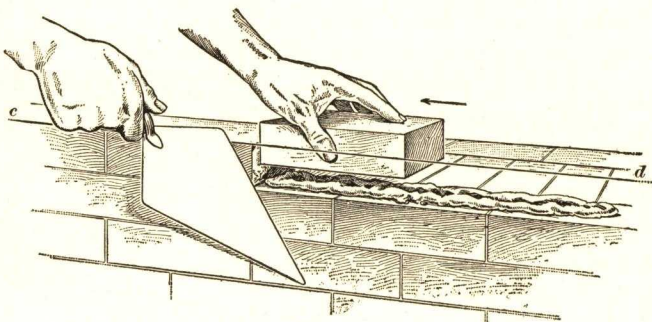


FIG. 12

possible, should be warmed. The brick should be thoroughly dry and in addition should be heated. The mortar should be warmed by using hot water and heating the sand. The scaffold and the wall may be enclosed in tarpaulins, which are large sheets of heavy cotton cloth, and inside the tarpaulin enclosure fires may be kept burning in salamanders, which are sheet-iron cylinders supported on iron legs.

The work should be carefully protected at night by coverings of boards or tarpaulin and should be protected from snow and rain until the mortar has thoroughly set.

Salt is sometimes added to the water with which the mortar is mixed, to prevent its freezing until a very low temperature occurs. The salt, however, is apt to appear later on the face of

the wall in the form of a white efflorescence which disfigures the wall.

In very hot weather the brick should be thoroughly wet with water sprayed on them from a hose. If this is not done, the brick will absorb water from the mortar, which will prevent its setting.

SCAFFOLDING

45. Inside Scaffolding.—In erecting brickwork it is necessary to build scaffolding as the work progresses. The contractor naturally uses the cheapest type of scaffold that will serve his purpose, and will always use an inside scaffold instead of an outside one if the character of the work will permit. The reason is that the floorbeams can then be used to support the scaffold and the scaffold will not have to be built up from the ground.

46. When a simple job of brickwork is to be done, such as a plain building, the bricks are generally laid from the inside so that the inside scaffold can be used. Boards laid upon the floorbeams serve as a scaffold for the wall up to a height of about 4 feet 6 inches. A scaffold consisting of wooden horses with planks laid upon them serves for laying the upper half of the wall of the story. This process is then repeated, the same horses and planks being used over again.

47. Instead of wooden horses, square wooden frames, Fig. 13, braced at the corners, are often used. These are placed in an upright position and braced with boards placed diagonally. Planks are then placed on top of these frames.

48. Exterior Scaffolds.—Exterior scaffolding must be used when the outside face of a wall is to have an ornamental character or be trimmed with cut stone or terra cotta.

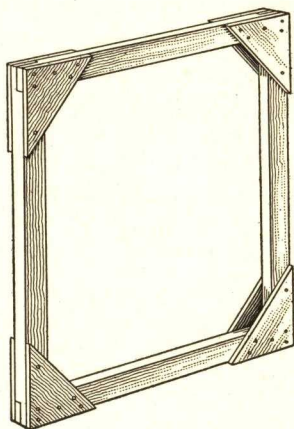


FIG. 13

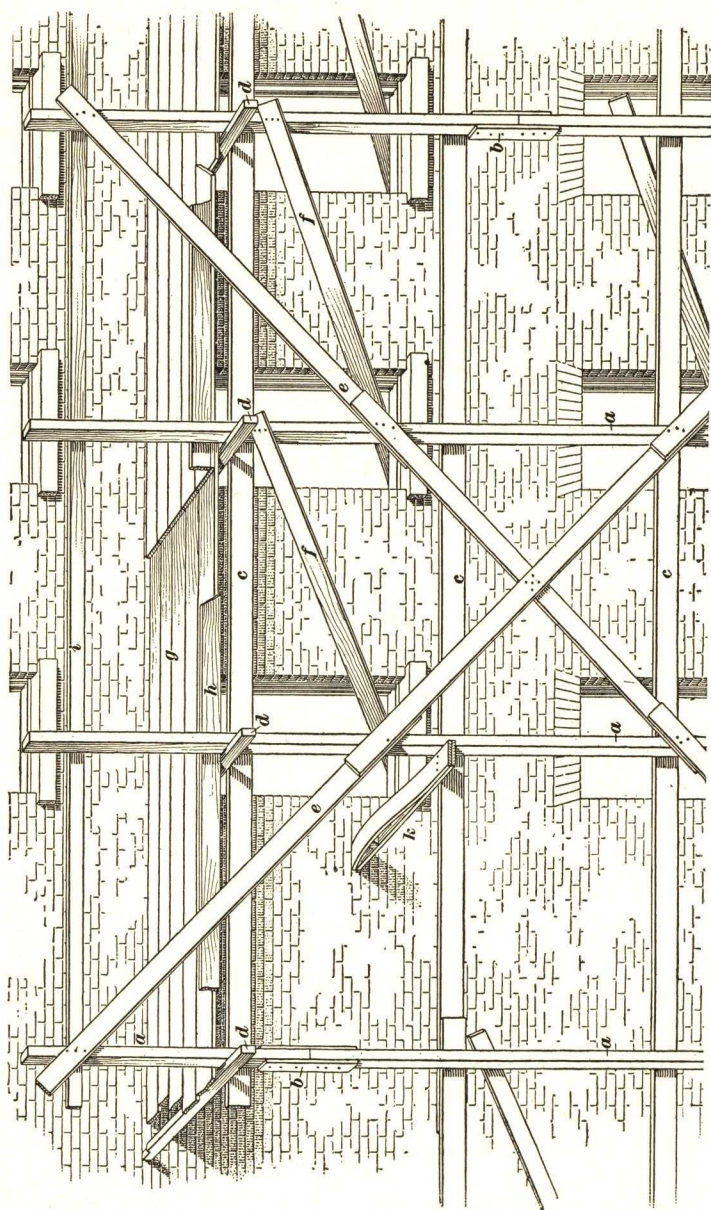


Fig. 14

The most common form of scaffolding used by masons is the **pole scaffold**. There are two types of the pole scaffold. One type depends partly upon the wall for support and the other type is built so as to be self-supporting and independent of the building.

A scaffold that receives some support from the wall is illustrated in Fig. 14. This scaffolding consists of uprights or poles *a*, which may be circular in cross-section, but which are generally in the form of small timbers, having a cross-section of 3 in.×6 in. for a five-story building and never less than 3 in.×4 in. The poles should be placed about 5 feet away from the face of the wall and about 7 feet 6 inches apart on centers. They should be firmly supported on the ground, and the lower ends should be braced so they will not slip. When they must be spliced together to make them longer, they are placed end to end and a piece of plank is nailed on each side of the joint as shown at *b*. These splices should not occur in all the poles at the same level. Ledger boards *c* are nailed to the poles to brace them horizontally and also to support the putlogs *d*, which sustain the floor of the scaffold. The other end of the putlog extends into the wall 4 or 5 inches. The uprights are braced diagonally by the braces *e* and to window frames by the window braces *f*. These latter braces prevent the scaffolding from falling away from the building.

What is known as a **spring stay** is shown at *k*. This device consists of two boards or planks, the ends of which are placed in a hole in the wall and a block is placed between them near to the wall. The block causes the boards to spread. The spread ends are brought together and nailed to the ledger. This action forces apart the ends in the wall so that they obtain a firm grip in the wall. The spring stay holds the scaffold firmly to the wall.

A platform *g*, formed of 2"×10" planks, which lap over each other at the ends, is laid on the putlogs. Foot-boards *h* are nailed on top of the platform against the uprights, also a guard-rail *i* is placed at a suitable height.

The entire structure should be thoroughly braced and well nailed with 10- or 12-penny nails.

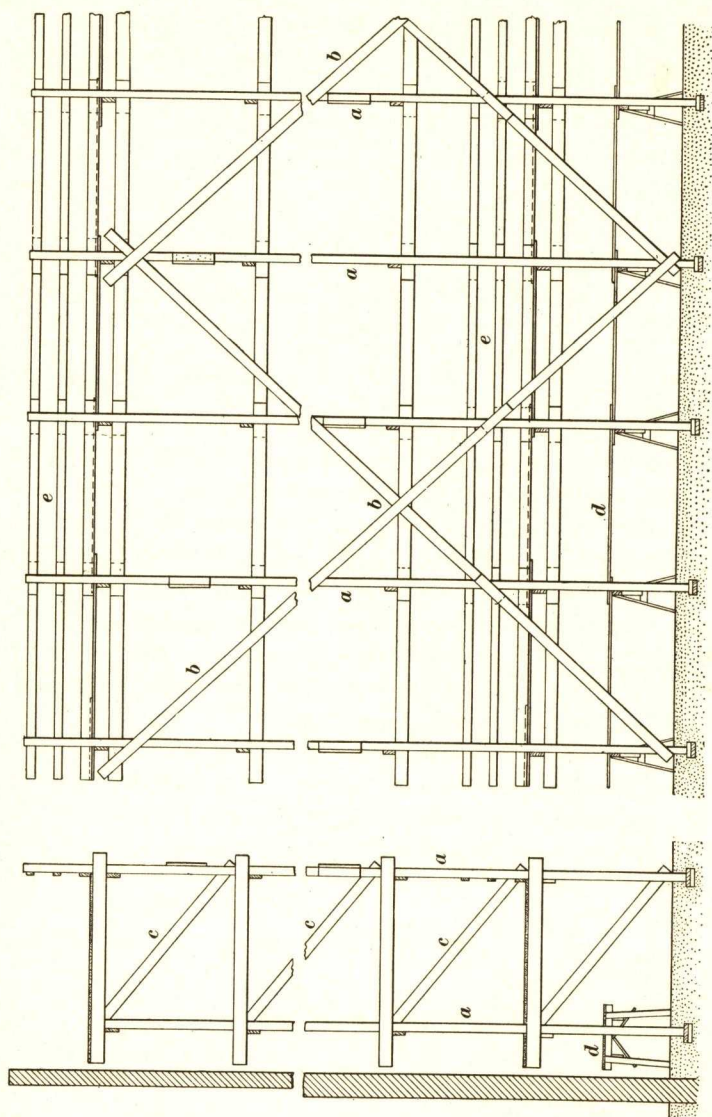


FIG. 15

49. A self-supporting pole scaffold is shown in Fig. 15. There are two sets of poles or uprights as shown at *a* in the side view. These are braced together, as indicated at *b* in the front view, as well as in a direction perpendicular to the wall, as at *c* in the side view. The planks of the working platform are carried on horizontal pieces which, as shown, do not touch the building. Putlogs are not used in this scaffold, as their use is likely to disfigure the face of the wall. It is always difficult properly to patch up the holes in the wall made by the putlogs, and for this reason it is desirable to use an independent scaffold. The upper part of the first-story wall is laid from the scaffold *d*, which consists of planks laid on horses. There are two guard rails shown at *e*. A scaffold of this description should not be used for a wall more than 100 feet in height.

50. A type of scaffold that is used when only one story of the wall, such as the cornice story, is required to be built from the outside, is formed by extending planks on edge out of the window openings and laying a platform upon them. Guard rails should be provided as in other scaffolds.

51. Suspended Scaffolds.—On tall, skeleton-construction buildings, suspended scaffolds are used. Steel beams called outriggers are supported on the floorbeams of the upper part of the frame of the building and project out 5 or 6 feet beyond the face of the wall. From these projecting beams the scaffold is suspended by means of wire cables. The cables are attached to the scaffold by means of devices by which the cable can be rolled up and the scaffold thus raised as required.

BRICK WALLS

TYPES OF BRICK WALLS

52. Solid Walls.—The brick wall most universally used and which is cheapest to construct is the *solid* wall. This wall consists of a solid mass of brickwork with no hollow spaces constructed in it. Such a wall is substantial, easy to build, and when properly constructed will last for centuries.

53. There are certain disadvantages characteristic of brick walls, and these result from the porosity of the brick and mortar. Unless a wall is built of good hard-burned brick and laid up with a properly proportioned mortar, moisture is likely to find its way through it. Some method is, therefore, generally adopted to prevent this moisture from reaching the inner surface of the brickwork, especially when plastering is applied directly to the brick.

54. One of these methods is to coat the inner surface of the wall with a damp-proofing compound which fills the pores on the inner surface of the wall and adheres strongly to the brickwork. At the same time this compound affords a good key for the plastering.

Another method is to form the inside 4 inches of hollow bricks or 8 inches of hollow tile, but while plastering applied directly to these surfaces will hold satisfactorily, the bonding courses of the joints are apt to become damp on the inside during wet weather.

55. The best and cheapest method of preventing water from reaching the plaster is to furr the walls. This may be done by nailing wooden **furring strips** about 1 inch by 2 inches in size to the inner face of the wall and nailing wood or metal lath to them to receive the plastering. Metal rods or furring may be stapled to the walls and metal lath fastened to them, or one of the several types of *self-furring* metal laths may be used. Terra-cotta furring may be applied to the entire face of the wall, such furring being held in place by the use of mortar and nails.

56. Hollow Walls.—Hollow walls, or more properly, double walls, are sometimes built and are intended to keep moisture from passing through, and by providing a complete separation of one wall from the other, keep the building cooler in summer and warmer in winter. Difficulties that largely offset their advantages are met with in construction, however, so that hollow walls are not often used in the United States. The objections to hollow walls are that more ground area is

required, thicker foundations are needed, the cost of construction is increased, and there is no assurance that the two walls are better than one solid wall properly furred.

57. Party Walls.—A **party wall** is a wall that separates two adjoining buildings and carries the floor and roof beams of both of them. The floor loads on party walls are twice as great as the load on any outside wall.

Building regulations in regard to the thickness of party walls are based on the span of the joists or width of building, and on the height. The specifications of the Committee on Building Construction of the National Fire Protection Association require all party walls and fire walls to be of solid masonry and almost all building codes require solid brick, not only as fire protection but to afford the property owner on each side the opportunity to insert or hang joists at any desired level or place.

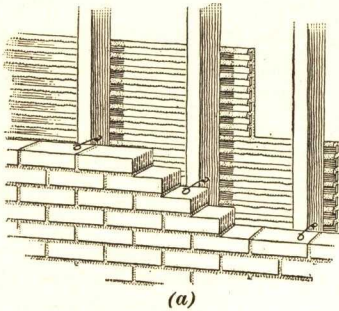
58. Fire Walls.—The National Fire Protection Association has defined a fire wall as follows: "The term **Fire Wall** indicates a wall subdividing a building to restrict the spread of fire. In all buildings it shall start at the foundation, be continuous through all stories and extend at least 3 feet above the roof."

59. Panel or Enclosure Walls.—In modern skeleton construction, the floor loads in a building are carried on the steel or reinforced-concrete frame, and the walls carry no load other than their own weight. Such walls are generally supported upon girders extending from column to column, usually at every floor. In this way much thinner walls can be used, and valuable space can be saved.

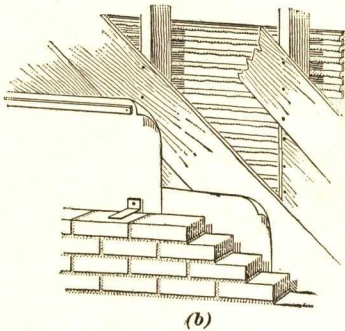
The New York City Building Code provides that "masonry walls supported at each story by girders may be 12 inches thick for the entire height of the building."

The Chicago building ordinances provide that "If buildings are made of fireproof construction, and have skeleton construction so designed that their enclosing walls do not carry the weight of floors and roof, then their walls shall be not less than 12 inches in thickness."

60. Curtain Walls.—Following is an extract in regard to curtain walls from the New York City building laws:



"Curtain Walls. Non-bearing walls built between piers or metal columns shall not be less than 12 inches thick for the uppermost 60 feet of height, increasing 4 inches in thickness for each next lower section of 60 feet." Curtain walls are not supported by beams, but rest on suitable footings supported on the foundation soil.



61. Veneered Walls. Frame houses are frequently incased in a 4-inch veneer of brick, separated from the wood by a 1-inch or a 2-inch air space. Veneered walls are generally somewhat cheaper than those built of solid brick. Houses constructed in this fashion are warmer in winter and cooler in summer, and are also less likely to catch fire from outside sources than are ordinary frame buildings.

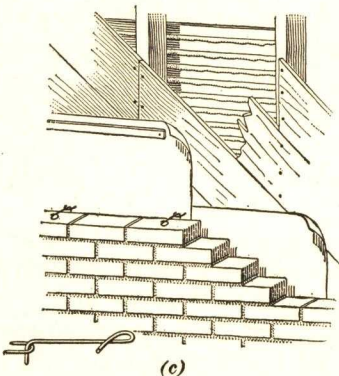


FIG. 16

4 inches for brick. The 1 or 2 inches allowed for an air space is also necessary to accommodate the mason's fingers

62. In building a house with veneered walls, the foundation must project far enough beyond the line of the studs to carry the brickwork that is put on later. This requires a projection of 1 inch for sheathing, 1 or 2 inches for air space, and

when he is laying the brick, and is frequently called a *finger space*.

Care must be taken to construct the frame in the best manner, for the brick veneer carries absolutely no part of the building except its own weight, and in fact has to be tied to the wood framing for support. After the frame is up it should be sheathed diagonally and the sheathing should, as a rule, be covered with tar paper or other waterproof material on the

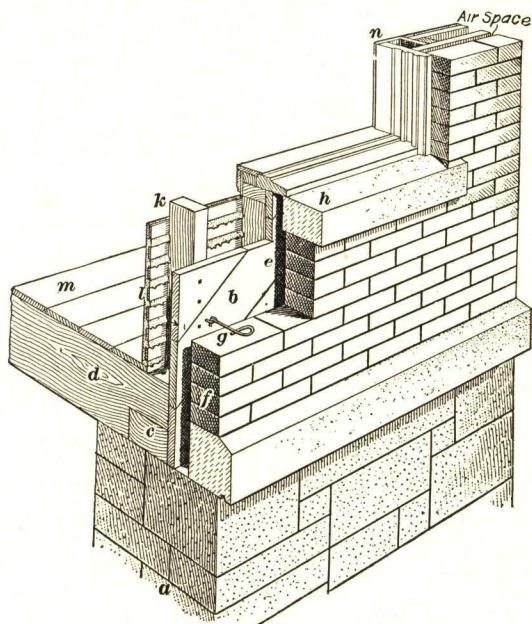


FIG. 17

outside before the bricks are laid. The sheathing is omitted in a very cheap form of construction such as is shown in Fig. 16 (a). This form of construction is not to be recommended, however. The tar paper is omitted in Fig. 17 for the sake of clearness. All the framing timber, particularly the sills, should be as dry as possible, and the frame must be perfectly plumb and straight; if not, the brick veneer will not lay up properly.

The brick veneer is usually tied to the diagonal sheathing or

to the studs with metal ties. The wire tie, shown in Fig. 16 (*a*) and (*c*), is most generally used, though a tie made of No. 16 iron, $1\frac{1}{4}$ inches wide, with the end turned up, as shown in Fig. 16 (*b*), gives satisfactory results. The ties are generally placed on every other brick in every fifth course of brickwork.

63. Fig. 17 shows a section through part of the foundation of a veneered building and the principal features of its construction. At *a* is shown the stone foundation wall, projecting 6 inches beyond the diagonal sheathing *b*; the 4"×6" sill is shown at *c*, the 2"×10" floor joists at *d*, and the air space between the brickwork and the sheathing at *e*. The 4-inch brick-veneer wall is shown at *f*, and the wire tie at *g*; the stone window sill is shown at *h*, the 2"×4" studding at *k*, the lathing at *l*, the flooring at *m*, and the window frame at *n*.

Due to the fact that any stability which a 4-inch brick veneer receives is dependent upon metal ties, which may rust, attached to a wooden building which may vibrate and will burn, this type of construction is not to be recommended, especially for any height above two stories.

64. Veneering on Hollow Tile.—Brick, especially face brick, may be used as a veneer on hollow building tile or back-up blocks. A wall of this description is generally damp-proof, and plastering can be applied to the inside face of the terra cotta without the danger of dampness affecting it. Such walls will be more fully described later in the Section on *Hollow Tile*.

THICKNESS OF WALLS

65. The thickness of walls in brick masonry is a matter that cannot be determined by calculations. Experience must be followed and also the regulations laid down in the building codes of different cities. The latter is the better plan, as the stipulations given in these codes are the result of experience of many men, and there are thousands of buildings to show the successful application of the rules given in these codes.

66. According to the New York City Building Code.—The New York Building Code makes the following

provisions for structures where the walls are entirely of brick and support the floors and roofs, and where no steel columns or beams are built into the walls:

Residence Buildings.—Except as otherwise provided, the thicknesses of brick walls of residence buildings hereafter erected shall be not less than the following: (a) When over 75 feet in height, 12 inches for the uppermost 25 feet, 16 inches for the next lower 35 feet, 20 inches for the next lower 40 feet, with a 4-inch increase for each additional lower section of 40 feet; (b) when not over 75 feet in height, 12 inches for the uppermost 55 feet, and 16 inches below that.

Public and Business Buildings.—Except as hereinafter provided, the thickness of masonry (brick) walls of public and business buildings hereafter erected shall be not less than the following:

(a) When over 75 feet in height, 16 inches for the uppermost 25 feet, 20 inches for the next lower 35 feet, 24 inches for the next lower 40 feet, and increasing 4 inches for each additional lower section of 40 feet.

(b) When over 60 feet and not over 75 feet in height, 16 inches for the uppermost 50 feet, and 20 inches below that.

(c) When over 40 feet and not over 60 feet in height, 12 inches for the uppermost 20 feet, and 16 inches below that.

(d) When not over 40 feet in height, 12 inches throughout.

Increased Thickness When Required.—(a) Every bearing wall with face brick bonded with clip courses or ties, and every bearing wall faced with ashlar, shall have a total thickness of at least 4 inches more than otherwise required unless the ashlar is at least 8 inches thick in every alternate course and bonded to the wall:

(b) When the clear span between bearing walls is over 26 feet, such walls shall be increased 4 inches in thickness for every $12\frac{1}{2}$ feet or part thereof that said span is over 26 feet.

(c) All walls over 105 feet long between cross-walls or proper piers or buttresses, shall be increased in thickness over the minimum requirements at least 4 inches for every 105 feet, or part thereof, over 105 feet in length.

(d) If the horizontal section through a bearing wall shows more than 30 per cent. area of flues and openings, such part of the wall where the excessive openings exist shall be increased 4 inches in thickness over minimum requirements for every 15 per cent. or fraction thereof, of flue or opening area in excess of 30 per cent.

General Reservations.—Nothing in these laws shall prevent the use in any wall of the same amount of material in piers and buttresses as is required for the thickness prescribed.

The unsupported height of any wall or part thereof shall not exceed 20 times the thickness of such unsupported part, unless reinforced by adequate cross-walls, buttresses, or columns.

67. According to the Chicago Building Ordinances.—The ordinances of Chicago group buildings into several classes and specify certain conditions that apply to these different classes. Where the walls of the buildings are entirely of masonry and support the floors and roof, the following general regulations are prescribed:

Brick, stone, and solid concrete walls, except as otherwise provided, shall be of the thickness in inches indicated in the following table:

Number of Stories in Building	Story												
	Basement	1	2	3	4	5	6	7	8	9	10	11	12
	Thickness of Wall, in Inches												
One.....	12	12											
Two.....	16	12	12										
Three....	16	16	12	12									
Four.....	20	20	16	16	12								
Five.....	24	20	20	16	16	16							
Six.....	24	20	20	20	16	16	16						
Seven....	24	20	20	20	20	16	16	16					
Eight....	24	24	24	20	20	20	16	16	16				
Nine.....	28	24	24	24	20	20	20	16	16	16			
Ten.....	28	28	28	24	24	24	20	20	20	16	16		
Eleven..	28	28	28	24	24	24	20	20	20	16	16	16	
Twelve ..	32	28	28	28	24	24	24	20	20	20	16	16	16

There are modifications in these thicknesses that may be made under certain conditions, and when building where this code is in force a copy of the ordinances should be obtained and carefully followed. For instance, certain provisions are made for the use of 8-inch or 9-inch walls in dwellings and other small buildings, and these and other provisions must be complied with where such laws are in force.

BOND IN BRICKWORK

68. Necessity for Bond.—To build a strong, substantial, and solid wall with such small pieces of material as bricks, requires a careful arrangement of the bricks in the body of the wall so that they shall be tied together and form a cohesive mass of masonry. Tying the bricks together is done partly by good mortar and largely by proper bonding. **Bonding** may be described as the process of laying bricks so that one brick shall rest on parts of two or three bricks below it. The *bond* in a wall is the result obtained by *bonding*. Brickwork that is not

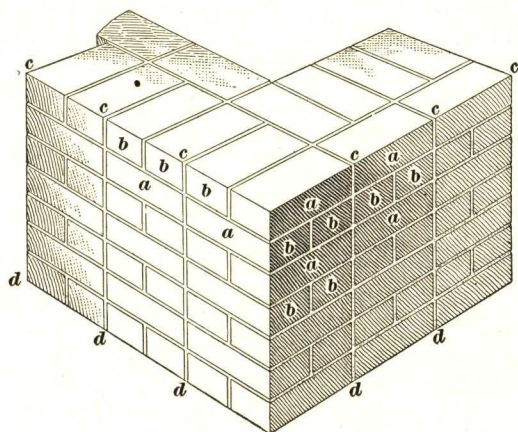


FIG. 18

properly bonded is shown in Fig. 18. By placing the brick in this manner, the wall is merely a series of piers that abut each other on the lines *c*, *d* and have no bond or union between them other than that obtained by the adhesion of the mortar.

The object of the standard bonds, that will be described presently, is to tie the wall together both longitudinally, or in the direction of the length of the wall, and transversely, or in a direction perpendicular to the face of the wall. The best brickwork is that in which the bricks are most thoroughly tied or bonded together, both lengthwise and crosswise, as well as vertically.

69. Terms Used in Bonding.—When brick are laid lengthwise in the face of a wall, as at *a* in Fig. 18, they are termed **stretchers**. When placed crosswise so that their ends are exposed in the face of the wall, as at *b*, they are called **headers**. A **course** means a horizontal layer of brick or one horizontal layer of brick and one horizontal mortar joint. Parts of bricks, that are made by cutting the whole brick, are called **bats** or **closers**. The different bats used in brickwork are shown in Fig. 19. A whole brick is shown in (*a*). When a brick is cut longitudinally, as in (*b*), on the line *a b*, each half is called a **queen closer**. It is difficult, however, to cut a brick in this manner, hence it is first cut on the line *c d e* and

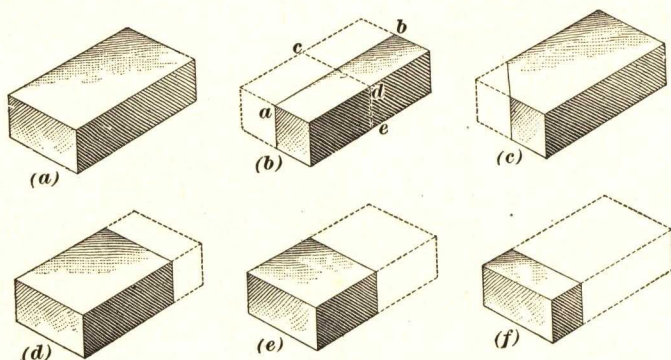


FIG. 19

each half is cut along the line *a b*. When a brick is cut as in (*c*), it is called a **king closer**. When one-fourth of a brick is cut off as in (*d*) the remainder is called a **three-quarter bat**. In (*e*) is shown a **half bat** and in (*f*) a **quarter bat**. A **closer** is a bat used to fill up a space near the end of a wall, resulting from the longitudinal bond used in the wall. Closers are illustrated in Fig. 20 at *c*.

70. Bonding is accomplished by lapping one brick over portions of two or more bricks in the course below. This process is often referred to as **breaking joints**. The vertical joints should not come one above the other in the face of the wall as shown in Fig. 18, but should alternate as shown in Fig. 20. This is done systematically so that the vertical joints shall

occur in plumb lines. The vertical joints in one course should be kept perpendicular, or directly over those in the second course below.

The joints in both faces of the wall should be directly opposite each other. This arrangement of the joints in the top of the wall is shown in Figs. 16, 21, 22, etc.

STANDARD BONDS

71. In the course of time there have been developed several standard methods of bonding brickwork such as the English, Flemish, American, Running, etc. bonds.

72. English Bond.—The **English bond** is probably the best and strongest method of bonding brickwork. In this

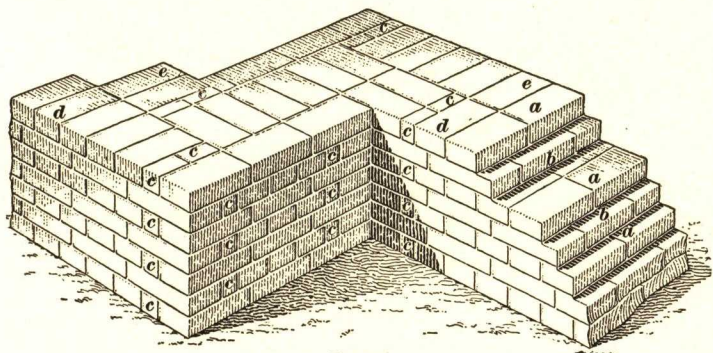


FIG. 20

bond, header and stretcher courses are laid alternately, as shown in Fig. 20. Joints are broken in the longitudinal bond courses by the use of quarter-bat closers, marked *c*. This is without doubt the best and simplest bond to use in all work where strength is required, as by its use a complete and thorough transverse bond is formed. It will be observed that the heart of this wall, which is about 16 inches thick, consists entirely of headers, and that the joints of the header course, as at *a*, are well bonded by the headers *b* of the stretcher course.

73. The wall shown in Fig. 20 has only two different courses. The arrangement of the bricks in these courses is

shown in Fig. 21 in courses *A* and *B*. By studying these plans in connection with Fig. 20 there should be no difficulty in understanding the construction of the wall. At *c* are shown

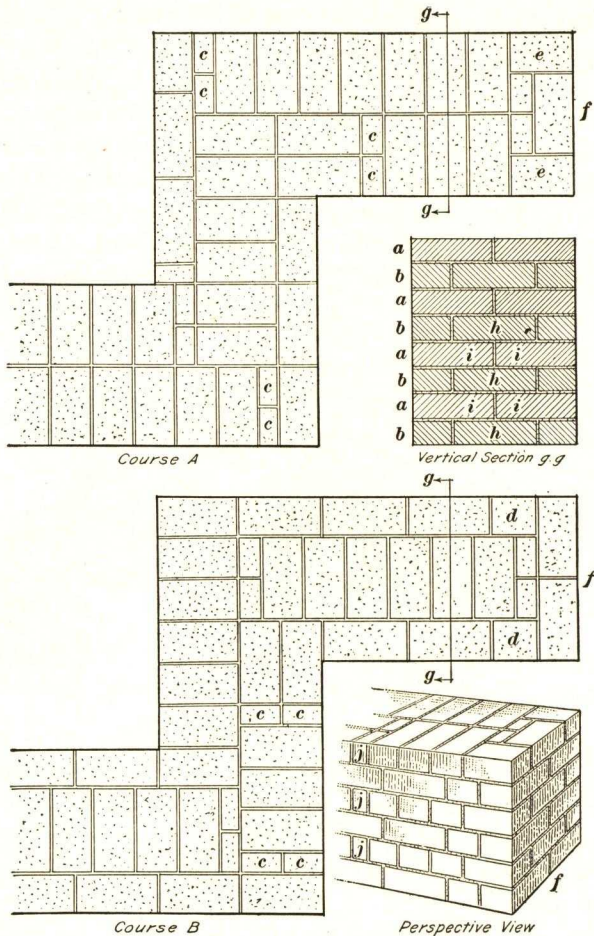


FIG. 21

queen closers; at *d*, half-bats; and at *e*, three-quarter bats. These latter are used in forming the end *f* of the wall.

In the vertical section through the wall taken through *g g* are shown the cross-ties formed by the bricks *h* lapping over

the bricks *i*. The perspective view shows the arrangement of the bricks in the face of the wall. The closers are shown at *j* and the end of the wall at *f*.

74. Flemish Bond.—The **Flemish bond** is one in which each course is composed of alternate headers and stretchers. The method of laying the bricks in this bond is illustrated in Figs. 22 and 23. Bats *a* and *b* are used at the corners of the walls and at *c* on the interior of the wall. In this example the headers and stretchers on the inner face of the wall are exactly opposite those on the outer face, and the wall is said to be built in **double Flemish bond**. The vertical section is taken through *e e* on the plans of the courses

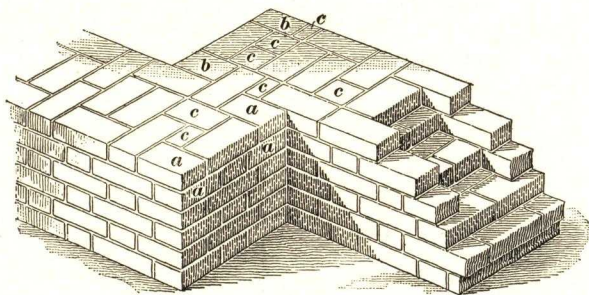


FIG. 22

A and *B* and shows the bond. The perspective view shows the appearance of the bond in the face of the wall and the jamb *f*.

75. American, or Common, Bond.—The bond most extensively used in the United States is known as the **American, or common, bond**. It is, in fact, a modification of the English bond. Instead of making every other course of brick a header course, as in the English bond, every fifth, sixth, or seventh course is made a header course in the American bond, with stretcher courses in between. This construction is illustrated in Fig. 24. Plans of the different courses are shown in Fig. 25, in which (*a*) and (*b*) are the courses that form the cross-bond, and (*c*) and (*d*) the stretcher courses in between. The arrangement of these courses is shown in the vertical sections (*f*) and (*g*).

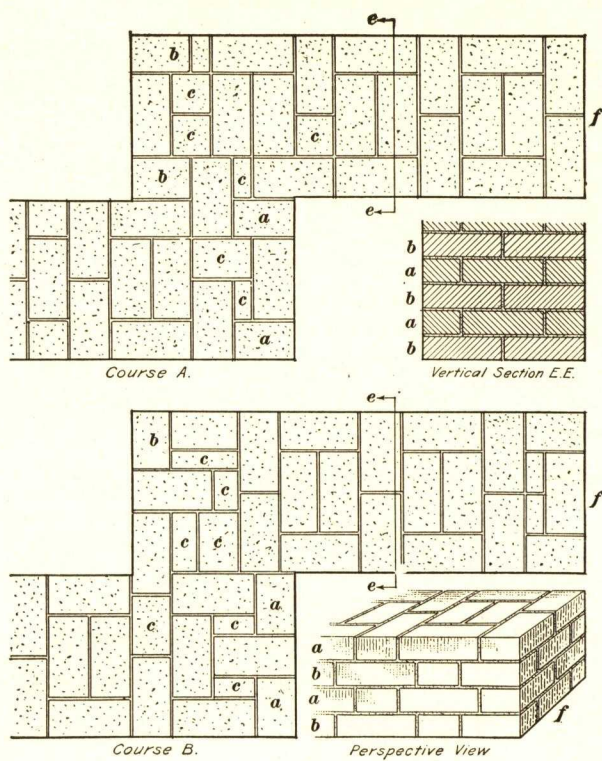


FIG. 23

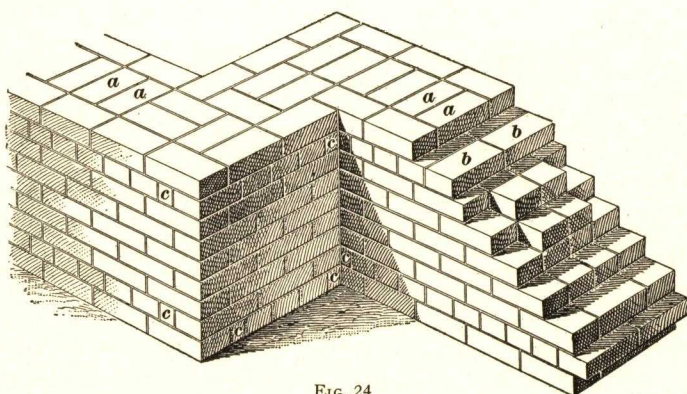


FIG. 24

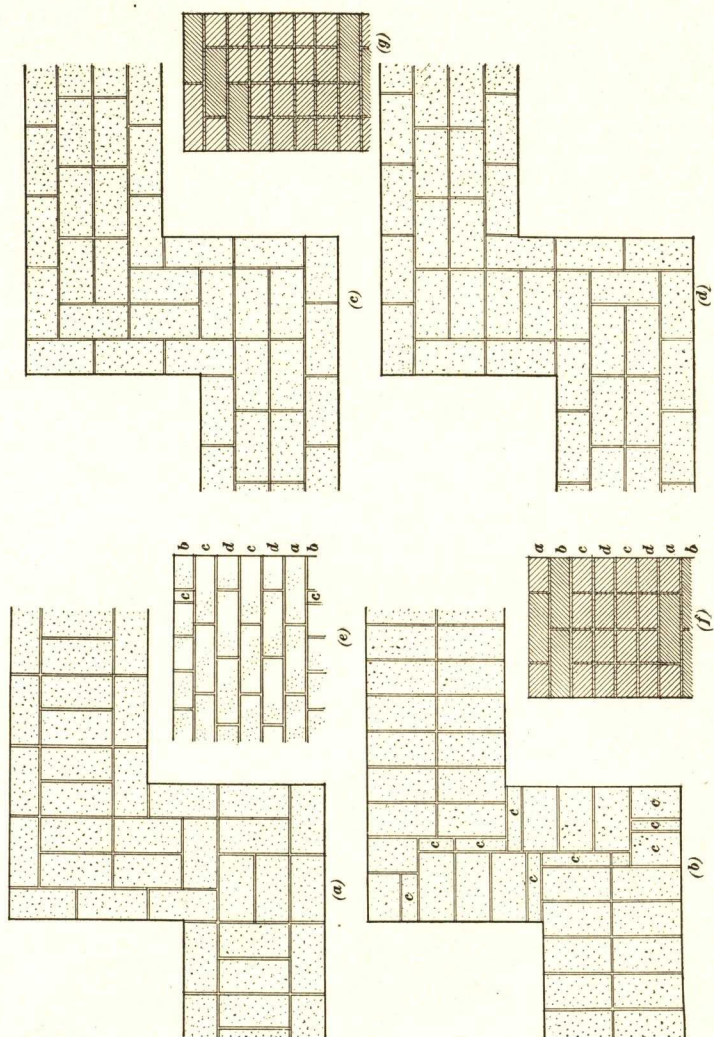


FIG. 25

The bond shown in (f) is formed by the two header courses *b* placed at the same level on the outside and inside faces and a course *a* lapping over both headers. This treatment brings the heading courses at the same level on both sides of the wall.

In (g) is a slightly different arrangement which is often used. In this case the header course on one side of the wall is lower than the header course on the other side.

The courses (a), (b), (c), and (d) are laid out according to the section (f). The arrangement of the bricks in the face of the wall is shown in (e). This form of bonding makes a wall that can be quickly and therefore cheaply built.

76. American bond is generally used in the United States not only for building walls of common brick, but also for backing up terra cotta, stone, and face brick. In fact the backing up is the real wall that not only supports the floor and roof loads, but also the weight of the facing.

The New York building laws require that every sixth course shall be a header course; that is, that five courses of stretchers must come between two courses of headers. For factory and warehouse purposes, where the walls have to sustain heavy weights, it is better to have every fourth course a header course, thus giving three courses of stretchers between the header courses.

BONDING FACE BRICK

77. Stretcher or Running Bond.—When a facing of brick is applied to a wall of common brick it is necessary to tie the facing firmly to the *backing*, or common-brick wall. This is done in different ways. When the facing is in running or stretcher bond there are no headers appearing in the face of the wall. In this case galvanized metal ties are generally used as shown in Fig. 26.

78. Face Bonds.—English and Flemish as well as other ornamental bonds are often used as facings only and are secured or bonded to a wall that is laid up in American or common bond. This can easily be done by extending some of

the numerous headers of the face bonds into the backing and thus securing an ample tie. The remaining headers will be composed of half-bricks or bats.

79. Metal Ties for Brickwork.—Fig. 26 illustrates the method of bonding in face brick with steel or galvanized-iron

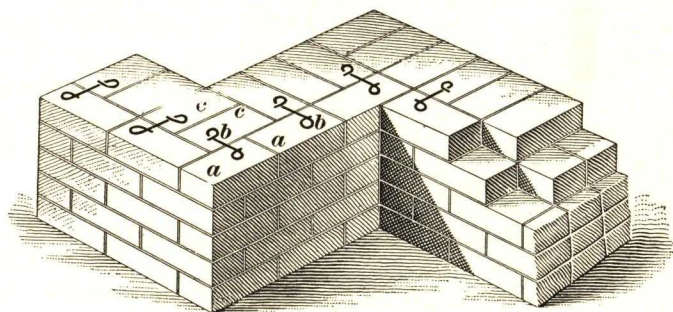


FIG. 26

wire. These wire ties *b* are twisted at the ends, and hold together the inside and outside courses *a* and *c*, as shown. They are laid in every sixth course of brick.

A still better method of tying front brick to the common brick in the rear of the wall is by the use of galvanized steel

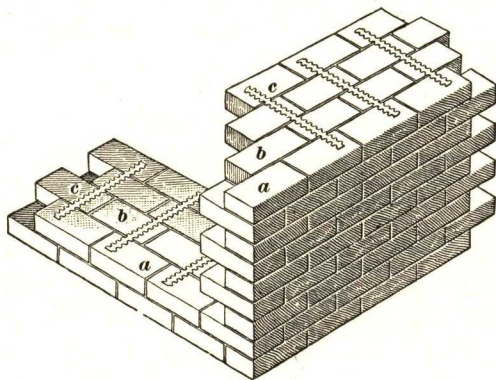


FIG. 27

ties from $\frac{3}{32}$ to $\frac{1}{8}$ inch thick, and having some of the metal punched out. The brick may be brought down to a very close joint, and the clinching edges make a very firm and satisfac-

tory binder. Fig. 27 shows the application of these bonding strips. Here, *a* is the pressed-brick facing, *b* the common brick in the rear of the wall, and *c* the steel ties bonding the pressed brick to the common brick.

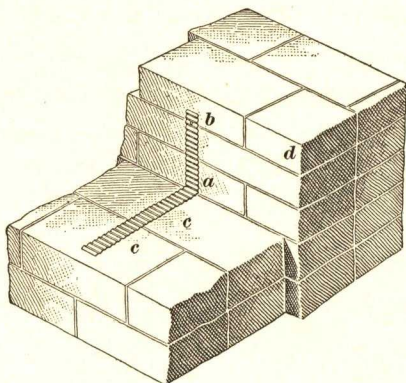
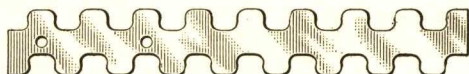
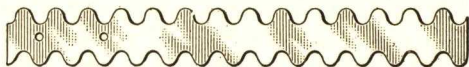


FIG. 28

Similar ties can be used for tying a new wall to an existing wall to increase its strength. The tie is bent near the middle, as shown at *a* in Fig. 28, and is nailed to the old wall with pointed wrought-iron nails, shown at *b*. These nails have

large flat heads made especially for this work, and are of sufficient size to make a firm connection for the new courses *c*.

Other forms of metal ties that are on the market are shown in Fig. 29. In using such ties it is generally advisable to use those that are sold in the local market.



BONDING HOLLOW WALLS

80. Before the introduction of metal ties, the bond between the two walls which form the hollow or double wall was accomplished with brick which were embedded in both walls and extended between them, tying them together.

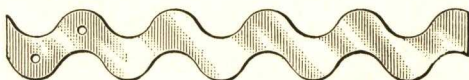


FIG. 29

This method was very expensive, as it required considerable cutting of brick. It also reduced the effectiveness of the hollow wall, as it provided places in the bonding brick through which dampness might pass.

81. Bonding With Metal Ties.—Bonding hollow walls by the use of metal ties is the cheaper and probably the better method, provided the ties are thoroughly protected from cor-

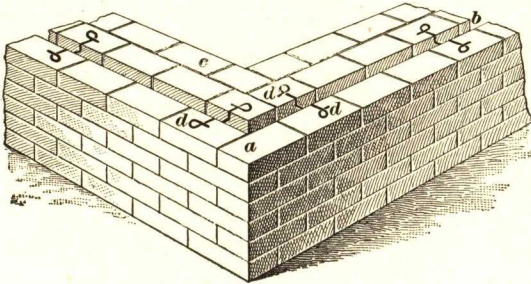


FIG. 30

rosion by galvanizing. These ties make the hollow wall effective, as the ties will not carry moisture to the inner wall.

At *a*, Fig. 30, is shown a 4-inch wall; at *b*, the air space; at *c*, the inner 8-inch wall; and at *d*, the metal ties. It should be said that hollow walls are not built very frequently, as the same results can be obtained at less cost by using hollow terra-cotta tile, called back-up tile, with a veneering or facing of brick.

BONDING WALLS AT ANGLES

82. In building brick walls, it is necessary that the angles in the walls be properly bonded. When the two walls forming the angle are carried up at the same time, the bonding at the corners is easily effected; if, however, one wall is built first, due to a delay in getting materials required for the other wall, particular care must be taken that the two parts will bond together properly.

In such cases, the wall first built is generally left toothed, as shown in Fig. 31.

In order to unite the two walls more firmly, anchors made of $\frac{3}{8}$ " $\times$ 2" wrought iron, with one end turned up 2 inches and the other turned around a $\frac{5}{8}$ -inch bar, should be built into the side wall about every 4 feet in height, as shown at *b*,

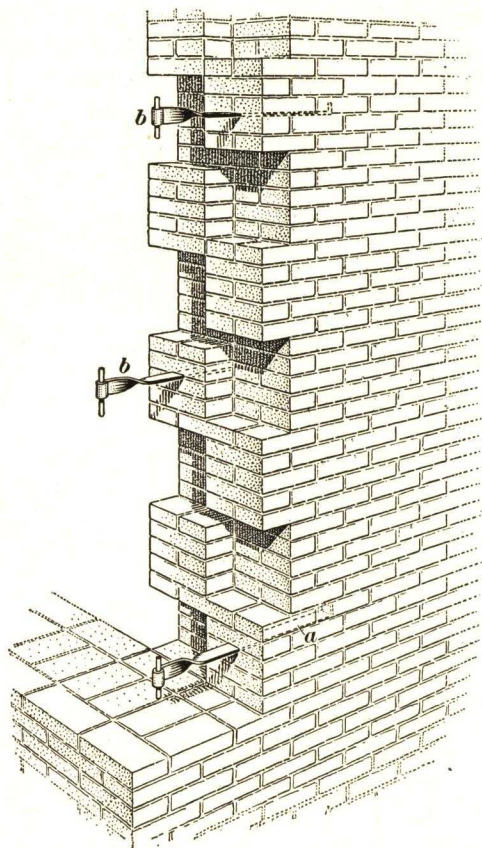


FIG. 31

Fig. 31. These anchors should be long enough to extend at least 12 inches, or the depth of one and one-half bricks laid the long way, as shown at *a*, into the side wall, and the center of the $\frac{5}{8}$ -inch bar should be about 8 inches from the back of the front wall.

JOINING NEW WALLS TO OLD WALLS

83. In joining a new wall to an old, a groove should be cut perpendicularly in the old wall, usually the width of a brick, so as to make a joint; this is called a *slip joint*.

This method of bonding is shown in Fig. 32. At *a* is shown the groove or chase cut where the new wall is to enter in the old wall; *c* is the new wall, and *d* the old wall.

In cheap construction, where new work is bonded into old, the method most commonly used is to nail a piece of

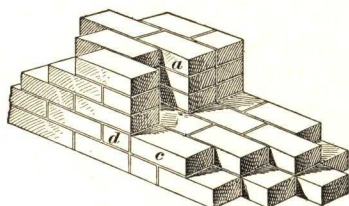


FIG. 32

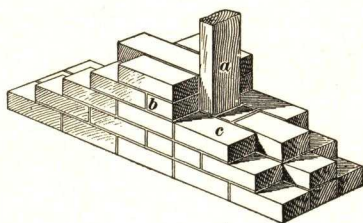


FIG. 33

2"×4" timber against the wall, as shown in Fig. 33, where *a* shows the 2"×4" timber spiked to the old wall and entering the center of the new wall. At *b* is shown the old and at *c* the new wall.

OPENINGS IN WALLS

84. Openings in Solid Walls.—When a brick wall contains door and window openings, their location and relative position should be very carefully considered, not only with regard to convenience and symmetry, but also with regard to their effect on the strength of the wall. When walls are broken frequently by windows and other openings, cracks are more likely to occur than when the wall is plain and unbroken. This is owing to the unequal pressure on the wall. If walls are well bonded and anchored, the danger of cracks will be reduced to a minimum. When possible, the window openings in the different stories should be placed directly over one another.

Unless absolutely necessary, the placing of windows under a pier or directly over a narrow mullion should be avoided. When such a design must be used, brick arches or metal beams, or both, should be built in if the span is great or the arch a *flat* one.

In any bearing wall carrying the ends of floorbeams, the combined horizontal area of openings should not be more than one-third the total horizontal area of the wall, unless the thickness of the wall between the openings is increased by the use of pilasters, or buttresses.

85. Relieving Arches.—Openings may be spanned at the top by means of arches or lintels. Lintels cannot be made

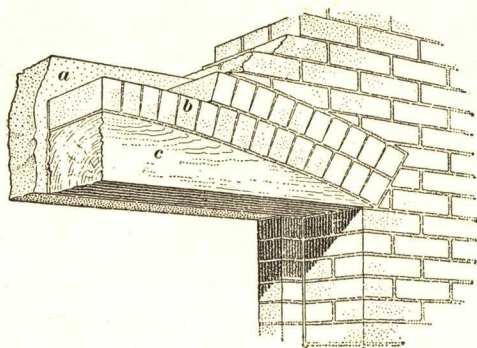


FIG. 34

of brickwork and are generally made of stone or reinforced concrete or a combination of metal and brick as described in the preceding article. When stone lintels are used they are generally only 4 inches in thickness and the remaining thickness of the wall must be supported either by steel or by brick **relieving arches**, such as shown in Fig. 34. These arches *b* are built upon solid wooden centers *c*, which are left in place after the arch is completed. The stone lintel is shown at *a*. Bricks laid in the manner shown at *b* are called *rowlocks*, and such arches, being made of two or more rows of rowlocks, are called *rowlock arches*.

BRICK ARCHES IN GENERAL

86. Arches should be laid up in cement mortar by careful and experienced workmen, or otherwise there is danger of the arches failing and letting down the weight imposed on them.

87. Definitions of Terms.—The following definitions of terms used in connection with arches are given. They may be readily understood by referring to Fig. 35.

Span.—The distance between the abutments, as shown at *a b*. The word *span* is also used to mean the material construction that spans, or covers, an opening or a gap.

Springer, or Skewback.—The stones or bricks that lie

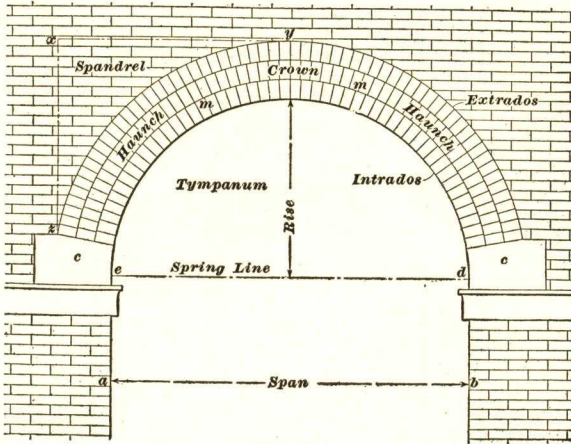


FIG. 35

immediately on the impost, as at *c, c*, from which the arch proper springs.

Spring Line.—A line drawn through the points where the arch intersects the abutments, or where the vertical supports of the arch terminate and the curve begins, as shown at *e d*.

Intrados.—The lower concave surface of the arch, formed by the under sides of the bricks, although considered by some authorities to be the concave line at the edge of the under side of the bricks.

Soffit.—The lower surface of the arch, or the intrados.

Extrados.—The upper convex surface of the arch formed by the outer sides of the bricks in the arch; also, considered by some authorities as the convex line of the curve of the outside of the arch.

Rise.—The perpendicular distance from the spring line to the highest point of the intrados.

Arch Ring.—The arch itself, contained between the intrados and the extrados.

Crown.—The highest portion of the arch.

Haunches.—The portions of the arch included between the crown and the skewbacks.

Tympanum.—The space between the spring line and the intrados.

Spandrel.—The triangular wall space included between the extrados, a horizontal line drawn through the top of the

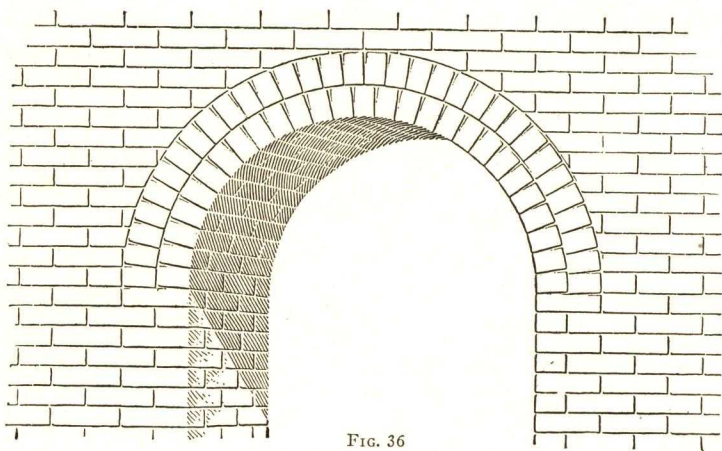


FIG. 36

extrados, and a vertical line drawn through the lower extremities of the extrados. This term is also applied to the space between two arches in a series of arches. The spandrel is shown at *z x y*.

Spandrel Filling.—The brickwork filling the spandrel.

Rowlock.—One of a series of arch courses, or rings, shown at *m, m*. There is no bond between these rings other than that afforded by the adhesion of the mortar.

88. Construction of Arches.—When semicircular arches are constructed of common bricks, the bricks are laid close together on the intrados, with wedge-shaped joints on the face of the arch; that is to say, the mortar joints are wider at the upper surface of the brick ring than at the lower surface, so that there is more mortar at the top of the joint than at the bottom.

Fig. 36 shows a semicircular arch consisting of two rings of rowlocks. These arch bricks are all laid as headers, and the long edges of the bricks show in the soffit of the arch. The increase of the thickness of the mortar in the joints is shown in the illustration.

89. Arches made of common brick are generally rowlock arches, and the difference in thickness of the joint in a distance of the width of one brick is not objectionable. An arch formed of bricks set with the length in the direction of the radius would require a decidedly greater thickness of joint toward the extrados than at the intrados. It is sometimes desired to use brick in this manner in connection with rowlocks in order to form a bond in the arch. In such cases it is necessary to have the bricks made to a radius, or wedge-shaped. Such bricks are called *gauged* or *shaped* bricks.

90. Gauged Bricks.—Fig. 37 shows a semicircular arch constructed of *gauged*, or *shaped*, bricks. The gauging, or shaping, may be accomplished by laying out the arch ring on a floor, and cutting, rubbing, or grinding the bricks to a certain gauge, or pattern, so that each brick will fit exactly in the place chosen for it; and all the mortar or radial joints will be of the same thickness throughout. This process is, however, expensive, and where there are many arches the brick should be molded in the required shape when manufactured.

In the example shown in the illustration, the space under the arch is filled by a brick wall supported on a bluestone lintel. This allows the bronze doors underneath to be made square on top.

As seen by the illustration, the extrados of the arch is stepped into horizontal steps. This is done so that the bricks

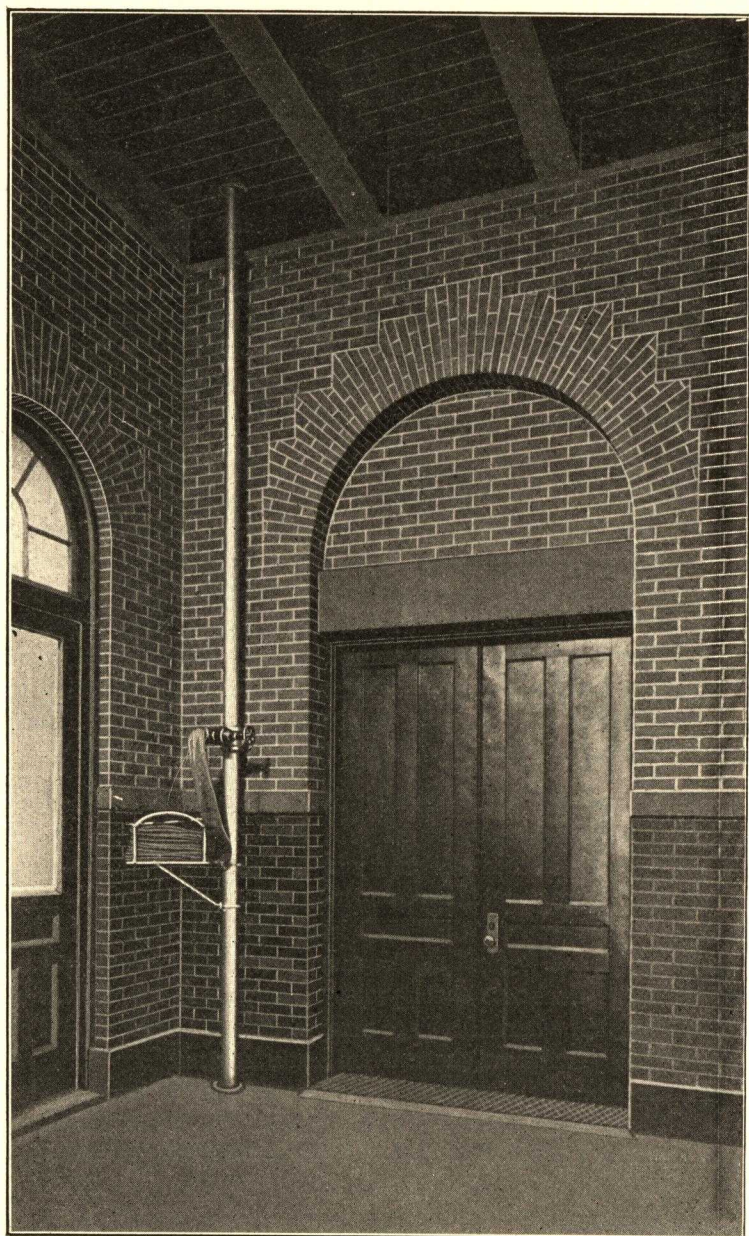


FIG. 37

in the wall will not have to be cut down to a knife edge in order to make them fit the work.

When the *reveal*, or space between a window or door frame and the outside of the wall, is only 4 inches, gauged-brick arches do not usually have any bond in the body of the wall except where metal ties are used; therefore, the bricks in the arch should be laid with great care and accuracy.

The class of work shown in the illustration is not often done in common brick, but is sometimes required in that material. The illustration shows the forms of bricks that will be required in such cases.

CHASES AND FLUES

91. Vertical grooves called *chases* and *flues* are frequently built in brick walls to receive plumbing, gas or heat

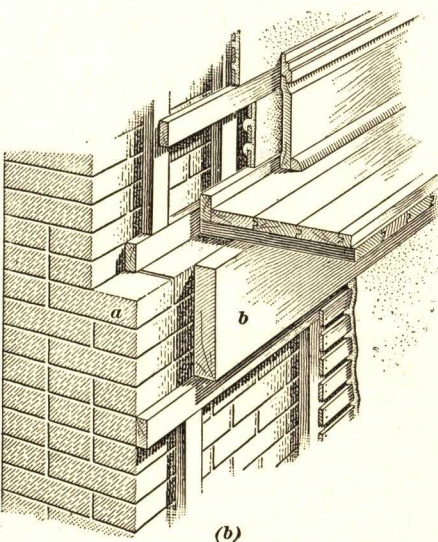
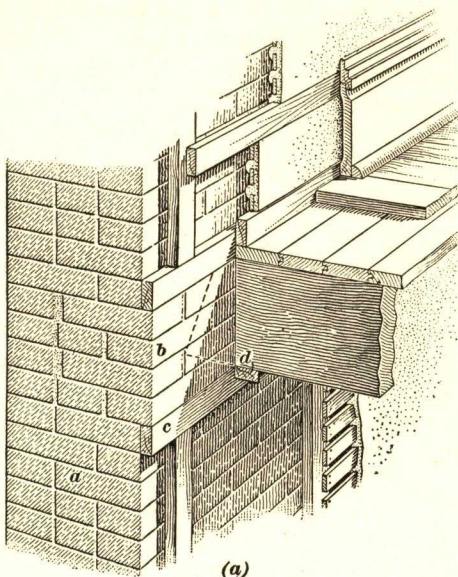


FIG. 38

pipes, etc. The building laws in some cities limit the number and size of chases that may be used in brick walls. For instance, the ordinances in force in New York City require that pipe chases shall not extend into any wall for more than one-third of its thickness and shall be not more than 4 feet in length measured horizontally. In the same ordinances, the areas of chases are counted in the areas of openings.

92. Fire-Stops.—Brickwork may be used to advantage as **fire-stops** to prevent the passage of flames from one floor to another back of the plastering. Brick walls are generally furred 1 inch, and this space, if continuous from floor to floor, permits the rapid spread of flames through the building.

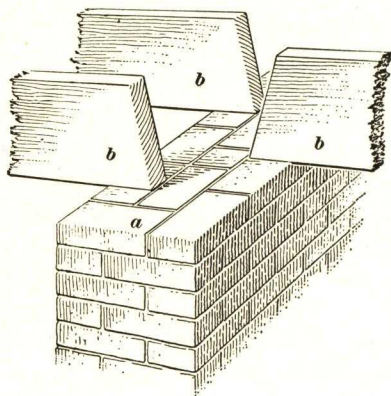


FIG. 39

Fig. 38 indicates a method of corbeling out the wall at the floor joists so as to close entirely the space between the wall and the plaster. At *a* in (a) is shown a wall of uniform thickness with the brick corbelled out at *b* for a fire-stop. A furring strip *c* makes a close joint with the cross-furring strip *d*. In (b) the brickwork sets back 4 inches, as the wall decreases in thickness at that point, as

at *a*, and *b* is a joist parallel to the wall. The wall should be carried up the full thickness to the top of the joists, and this will close all passages from floor to floor back of the plastering.

Where fire or party walls occur, the joists or beams should not be placed directly opposite each other, but should be staggered, as shown in Fig. 39. For adequate protection not less than 6 inches of brickwork should separate the ends of wooden joists. In Fig. 39 *a* represents a 12-inch wall supporting 2-inch joists on 16-inch centers. The joists *b* bear 4 inches on the wall and their ends are separated about $7\frac{1}{2}$ inches. With 3-inch joists similarly placed the ends of the

joists would be separated about $6\frac{1}{2}$ inches. Particular care should be taken to fill all joints in the brickwork with mortar, as unless this is done fire will find its way through from the end of one joist to the end of the other. In some cases it is difficult to secure 6 inches of brickwork between the ends of the joists, and in some cases steel beams may be used to secure the proper fire protection.

BACKING UP

93. As has been stated, common brickwork is frequently used in *backing up* stonework, terra cotta, and face brick. When this work is to be done, the stonework and terra cotta should be designed so that the heights of the courses shall be equal to the height of a definite number of brick courses, in order that the anchors or metal ties can extend back into the wall properly. For instance, with a customary size of brick, one course is counted as measuring $2\frac{1}{2}$ inches. The stone or terra cotta should be laid out in courses that are multiples of $2\frac{1}{2}$ inches in height. For instance, stone or terra-cotta courses should be made $7\frac{1}{2}$, 10, $12\frac{1}{2}$, 15, or $17\frac{1}{2}$ inches in height.

When a wall is faced with face bricks of other size than the common bricks used for backing, if the joints of the face brick are kept fine and those of the common brick thick, or vice versa, the courses will work out to the same height and permit of easy bonding every five to seven courses. As some Building Codes require frequent bonds, their provisions should be ascertained and bricks selected accordingly.

The same precaution should be taken in designing stone quoins, such as are used at corners of walls. The quoins should be designed to be a certain number of courses in height so that the bed joints of the stone will coincide with the joints on the brickwork.

EFFLORESCENCE

94. Very often, on buildings of stone or brick, more particularly the latter, white stains will appear on the surface of the walls after a few days of wet weather. These stains are

called **efflorescence**, and are due to certain soluble substances in the brick or mortar, or both. Carbonate of soda appears most frequently on new walls, and is due to the action of the lime in the mortar upon the silicate of soda in the bricks. Silicate of soda seldom occurs in bricks unless a salt clay is used in making the bricks. Sulphate of magnesia is formed when the clay contains pyrites, or when sulphurous coal is used for burning.

Water may reach the interior of the wall through absorption by the brick, through cracks and unfilled joints in the brickwork, through joints in the upper surfaces of copings or projecting courses, or from leaking or overflowing gutters and leader pipes back of the wall. When once the surface of the wall is penetrated, the moisture follows the joints and percolates to lower levels and to the outside surfaces, finally depositing the soluble substances by evaporation as stains or efflorescence.

Efflorescence may be prevented by the selection of impervious brick free from soluble materials, by filling all joints with mortar, by providing the upper surfaces of copings and projecting courses with overhanging coverings having drips, and by the proper design and maintenance of gutters and leader pipes.

Usually it is possible to remove efflorescence by washing the walls with a dilution of muriatic acid in 20 parts of water, which must be afterwards washed off with clean water. Several preservative coatings are designed to be applied to the walls after they are cleaned and dried. These preparations, by closing the pores in the brickwork, prevent the absorption of moisture. To be permanently effective, however, several coats must usually be applied, followed by additional coats at 2- or 3-year intervals.

HANGERS, ANCHORS, ETC.

95. The use of joist and girder hangers, etc. simplifies greatly the work of framing, both for house and mill construction. With these hangers and anchors, a good and firm bearing may be had in brick walls. The chief requisite of a good hanger is that it shall hold firmly to the wall and at the same

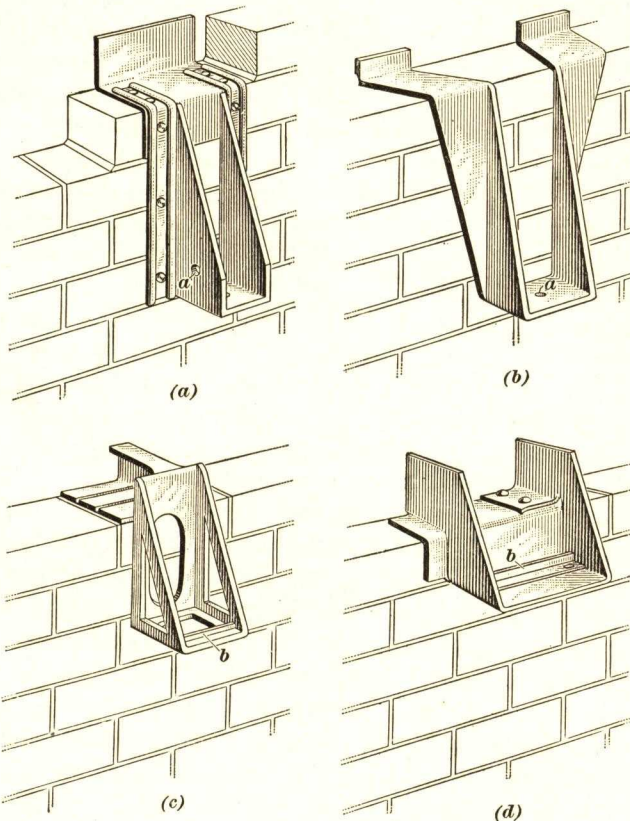
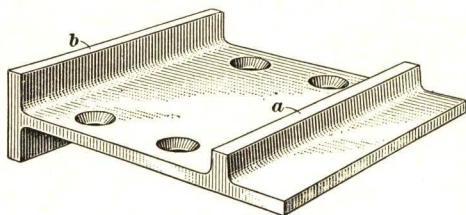


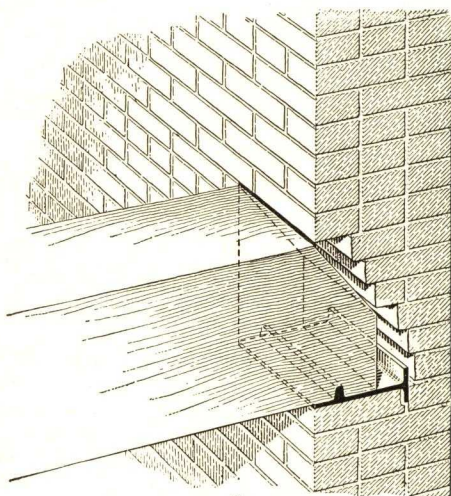
FIG. 40

time hold firmly to the joist. Fig. 40 illustrates four styles of hangers used to support joists and beams against brick walls. In none of these styles does the joist enter the wall, but rests in the socket; the top of the hanger being built into the wall.

In the hangers shown in (a) and (b), the joist is held in place by one or two spikes or lagscrews driven in through the hole *a* of the hanger and into the wood. In the hangers shown in (c) and (d), there is a ridge, or lug, *b* on the hanger. A notch is cut across the bottom of the joist and the ridge of



(a)



(b)

FIG. 41

metal fits into this notch. The hangers in (a), (b), and (d) are made of sheet steel stamped and bent into shape, while that shown in (c) is of cast steel. The hanger shown in (a) is known as a **Van Dorn** hanger; the one in (b) is a **Lane** hanger; and those in (c) and (d) are **Duplex** hangers. These hangers also act as anchors, as the end of the beam is held from moving horizontally either by spikes or by the lugs of the hangers. At the same time if the middle of the joist should fail and drop by overloading or by

fire, the end of the joist would easily fall from the hangers shown without injuring the wall.

96. In Fig. 41 is shown a wall plate that is used for wooden beams or girders that extend into the wall. In (a) is shown the bearing plate with the lug at *a* and the flange *b* which turns up and down into the wall. The beam is usually finished with

a bevel cut on the end, known as a **fire-cut**. This cut allows the beam to fall out of the wall without injury to the wall. The fire-cut is illustrated in (b).

97. In Fig. 42 are shown the four forms of iron anchors that are used for fastening beams in brick walls. The one

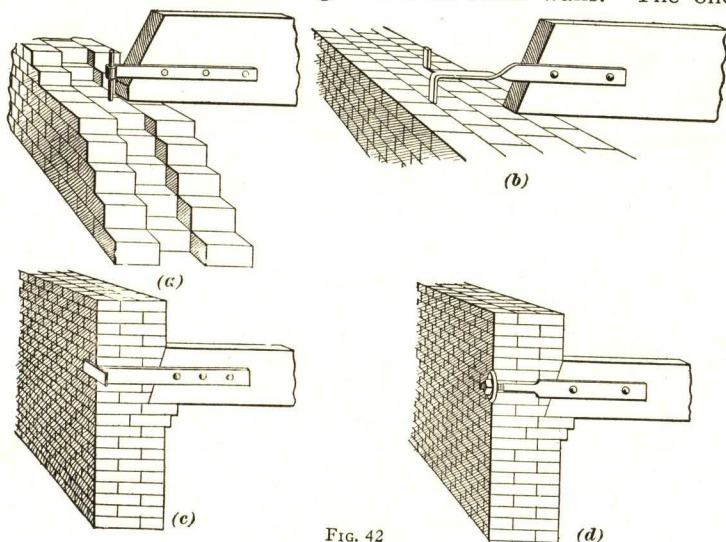


FIG. 42

shown in (a) is made of $\frac{1}{4}'' \times 1\frac{3}{4}''$ iron, about 2 feet long; the end built in the wall is made of a $9'' \times \frac{5}{8}''$ rod with the end of the anchor bent around it.

The anchor in (b) is made of $2'' \times \frac{3}{16}''$ iron, 2 feet long; the end that goes in the wall is cut as shown, and about 4 inches is

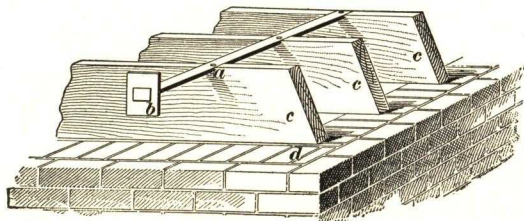


FIG. 43

turned at right angles to the anchor; the other end is twisted so that it can be nailed to the side of the joists.

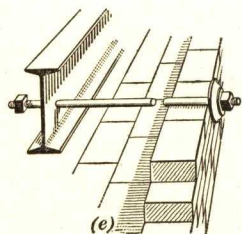
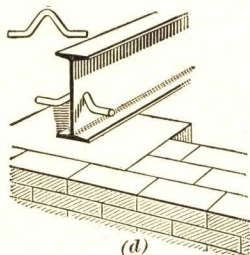
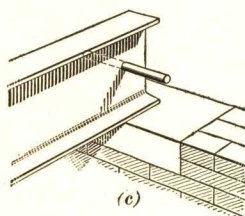
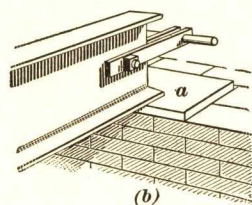
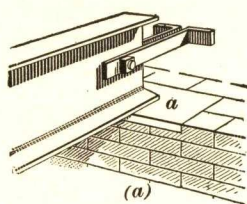


FIG. 44

An anchor that runs entirely through a wall is stronger than one that is simply embedded in a wall. On the other hand, the end of an anchor on the outside of a building makes an unsightly appearance. In warehouses and in back walls of buildings, however, when neat appearance is a secondary consideration, an anchor like that shown in (c) is used. It is made of $1\frac{3}{4}'' \times \frac{1}{4}''$ iron, 2 feet 6 inches long, and has a plate of $2'' \times 4'' \times \frac{1}{4}''$ iron forged on the outer end. This style of anchor may also be used in the middle of a wall in the same manner as those shown in (a) and (b).

In (d) is shown probably the strongest form of anchor. This style of anchor is made by flattening out a $\frac{3}{4}$ -inch bolt so as to make a $2'' \times \frac{1}{4}''$ portion to spike to the joist, and it is provided with a 5-inch cast-iron washer. A nut is placed on the outer side of the washer so that the anchor may be tightened up if necessary after the walls are built.

Anchors should always be spiked to the side of the joist or girder at or below the middle, as shown in the figure.

Fig. 43 shows the method of anchoring joists to walls where the joists and the walls run parallel. The anchor, let into the floor joists as shown at *a*, is provided with a washer *b*, and should be long enough to run over two or three joists, and 8 inches into the wall in order to give proper stiffness. The floor joists are shown at *c*, and the 12-inch brick wall at *d*.

98. Fig. 44 illustrates common forms of ties for anchoring I beams, channels, etc. to brick walls. Ordinary wall anchors are shown in (a), (b), (c), and (d), while in (e) is represented a tie-rod anchor running through the wall, to be used when the beam is run parallel to the wall.

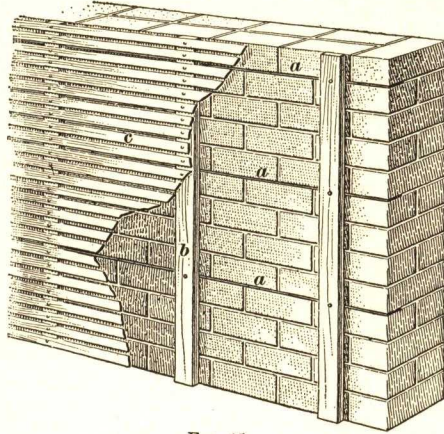


FIG. 45

Steel beams are generally supported on steel templets that are set in the wall. These templets, shown at *a* in (a) and (b), should be made large enough to distribute the load over a sufficient surface of brickwork so that the brickwork will not be crushed under the load.

99. Attaching Furring, Grounds, Etc. to Brick

Walls.—In most buildings it is necessary to attach wood or metal furrings, grounds, bucks, etc., to brickwork, and there are various methods used for this purpose.

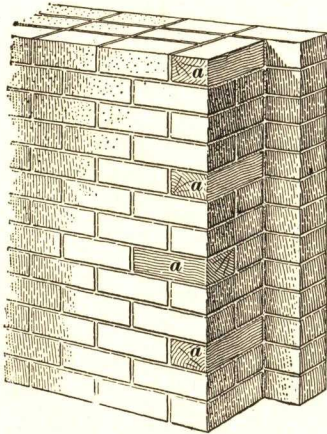


FIG. 46

Where the interior of the wall is to be furred with wood furring to receive lathing and plastering, common lath are laid between the bricks every few joints as shown at *a* in Fig. 45. They are held in place firmly by the brick and afford nailing for the furring. Wood should not be in-

serted in chimney walls and breasts, but metal furring and lath should be used, the furring being attached to wire loops

or other devices built in the brickwork. Nails should never be driven into a chimney wall less than 8 inches thick, as they are liable to break out the mortar on the inside and render the chimney defective.

100. In special places, such as at a door jamb, it is necessary to provide specially good nailing, and **wood bricks** are

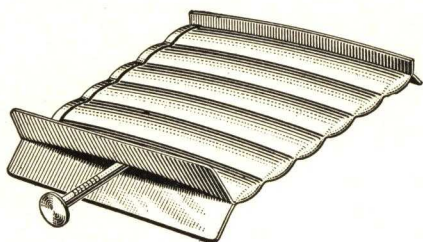


FIG. 47

built into the wall as shown at *a* in Fig. 46. These are blocks of wood of the same size as a brick and are built in the wall in the same manner as ordinary brick.

101. A patented device known as a wall plug is shown in Fig. 47. This consists of a bent corrugated piece of metal that is built into the joints of the brickwork and into which a nail can be driven securely.

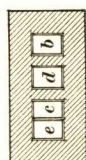
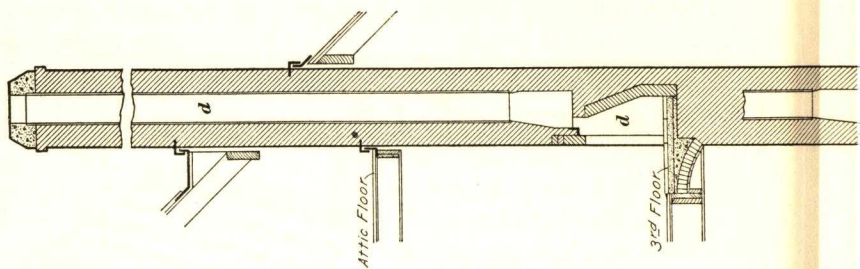
102. Devices for attaching work to brick walls, but which are not built in the walls, will be discussed elsewhere, as they do not properly come under the subject of brickwork.

CHIMNEYS AND FIREPLACES

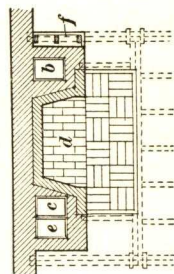
CHIMNEYS

103. Design.—The correct location, area, and height of chimneys should be carefully considered in designing a building. To make a chimney draw well, a separate flue should be provided extending from each fireplace, stove, or furnace to the top of the chimney. It is not considered good practice to use one flue for two or more of these features, although it is sometimes done with satisfactory results.

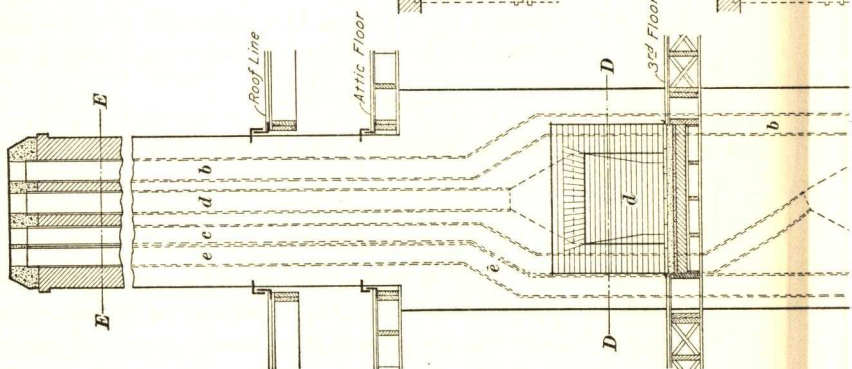
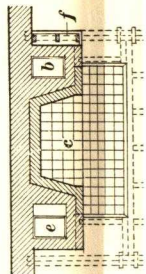
104. Construction of Chimneys.—Chimneys are generally constructed of brick and contain fireplaces, spaces for

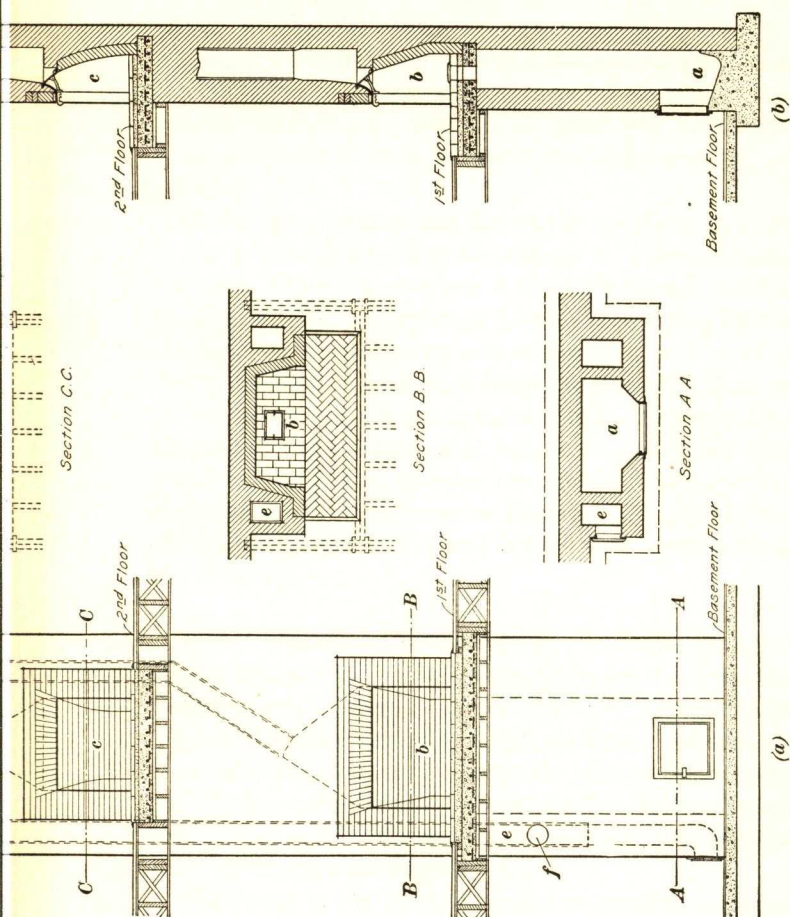


Section E.E.



Section D.D.



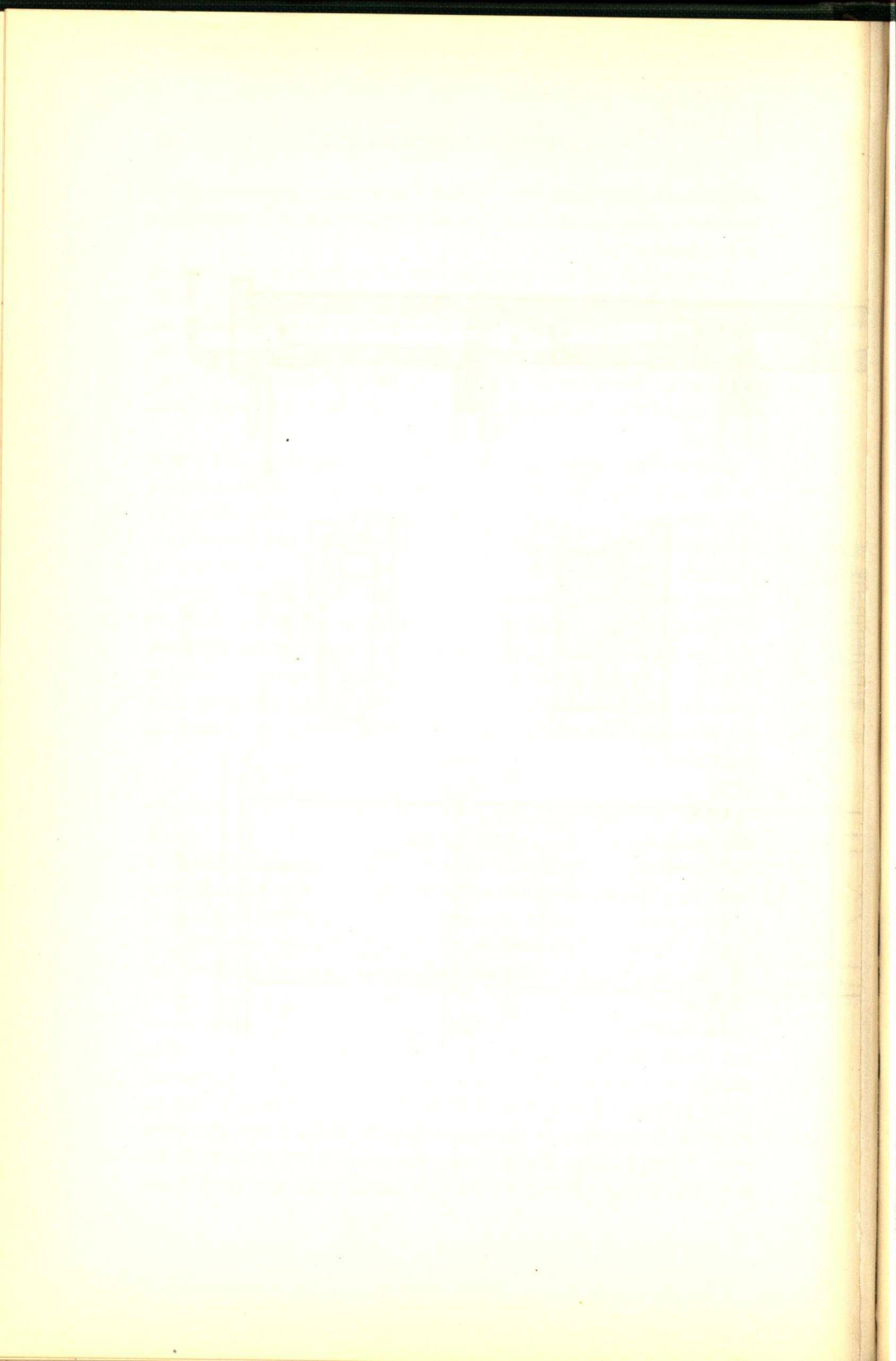


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(a)

FIG. 48

34795-34814



ranges, ash-pits, flues, etc. These features are combined so as to form a compact and economical structure which is sometimes very complicated.

An example of the arrangement of parts in a chimney is shown in Fig. 48, which is a chimney built in with the side wall of a brick building. In (a) is shown a front elevation of the chimney; in (b), a section through the center lines of the fireplaces. Between these views are shown horizontal sections or plans of the chimney at each floor, in the cellar, and above the roof.

In the upper stories are shown the fireplaces *b*, *c*, and *d* and in the basement or cellar the ash-pit *a*. This ash-pit receives the ashes from the fireplace *b* through the ash door shown in the section (b). The ash-pit is provided with a cast-iron door through which the ashes are removed. A flue *e*, shown in dotted lines in (a), reaches from the basement floor to the top of the chimney. At the bottom of this flue, near the floor on the side of the chimney, is shown an iron door for cleaning out this flue. At *f* is an opening into the flue *e* designed to receive a smoke pipe from a heater or furnace. The flue *e* runs up past the fireplaces *b*, *c*, and *d* and is then bent toward the center of the chimney.

105. Flues.—The flues from the fireplaces are similarly shown by dotted lines extending from points above the tops of the fireplaces to the top of the chimney. The brick partitions between chimney flues are called **withes**. As shown, the flue from any fireplace must pass on the side of the fireplace above, but the flues are deflected above the last fireplace and brought together so as to make the chimney, where it extends above the roof, as compact as possible.

The bends in the flues should be as gradual as possible so as not to check the flow of smoke and gases up the flue. The double dotted lines indicate that the flues are lined with terracotta linings. These flue linings should be carefully cut to miter or fit together at the bends so as to form a smooth channel. Flues having slight bends are considered preferable to perfectly straight flues, as the bends prevent rain and sleet from

falling into the fireplace, and also tend to check the downward passage of currents of cold air. The smoke flues are sometimes formed in brickwork without linings, in which case the walls of the chimney should be 8 inches in thickness. The interiors of such flues should never be plastered, as the plastering is disintegrated by the heat and will fall off. When flue linings are used the chimney walls need be only 4 inches in thickness. Where linings are not used a 4-inch brick partition, or withe, should be built between the flues. The building codes of many cities require that all chimney flues be lined with fireproof material such as terra-cotta flue linings.

106. The advantages of using terra-cotta flue linings are several. In the first place, they are made in 24-inch lengths, which makes few joints. The inside surfaces of the linings are smooth and thus facilitate the flow of smoke and gases up the chimney. In unlined brick flues there is always a risk that the joints between the bricks may not be properly filled with mortar and that sparks will find their way through the crevices and start a fire in adjacent wooden parts of the building. When the flues are lined, however, this danger is reduced to a minimum.

107. Sizes of Flues.—The sizes of brick flues are generally made in accordance with the sizes of bricks used on the work. These flues are about 4, 8, 12, 16, and 20 inches in either direction. Terra-cotta flue linings are made in circular, square, or rectangular shapes. The square and rectangular flue linings are made to fit in with the brickwork.

108. In Table II is given a list of the customary sizes of terra-cotta flue linings. The dimensions of the square and rectangular flues are the outside dimensions. The thickness of the shell, which is from $\frac{3}{4}$ inch to 1 inch, is deducted in estimating the net area of the flue. The inside diameters of the circular pipes are given and the areas are easily calculated from them. While $4\frac{1}{2}$ -inch flue linings are listed in Table II, this dimension in a smoke flue is too small to be effective and should not be used except where unavoidable or in fireplaces where only gas is burned, which permits of the use of a small flue.

109. Proportions of Flues to Fireplaces.—A good proportion for flues for fireplaces in which wood or bituminous coal is to be burned is to make the sectional area of the flue equal to one-tenth of the area of the fireplace opening if the flue is rectangular, and one-twelfth, if the flue is circular. Thus, for a fireplace that is 30 inches wide by 30 inches high and whose area is 900 square inches, the flue area for the rectangular form of flue would be 90 square inches, which will

TABLE II
DIMENSIONS AND EFFECTIVE AREAS OF FLUE LININGS

Rectangular Flues		Circular Flues	
Outside Size Inches	Approximate Inside Area Square Inches	Inside Diameter Inches	Inside Area Square Inches
$4\frac{1}{2} \times 8\frac{1}{2}$	16.25	6	28.27
$4\frac{1}{2} \times 13$	27.50	7	38.48
$4\frac{1}{2} \times 18$	40.00	8	50.27
$8\frac{1}{2} \times 8\frac{1}{2}$	42.25	9	63.62
$8\frac{1}{2} \times 13$	71.50	10	78.54
$8\frac{1}{2} \times 18$	104.00	12	113.10
13×13	121.00	15	176.72
13×18	176.00	18	254.47
18×18	256.00	20	314.16
		24	452.39

require an 8"×12" brick flue. If flue linings are used, an 8½"×18" or a 13"×13" flue will be required. The area of a circular flue lining would be $\frac{1}{12} \times 900 = 75$ square inches. The nearest stock size of lining is 10 inches in diameter, which, having an area of 78.54 square inches, would be satisfactory.

If anthracite coal is to be burned, the flue area may be made one-fifteenth of the area of the fireplace opening for a rectangular flue, and one-eighteenth for the circular form. Thus, for a fireplace with an area of 900 square inches a rectangular

flue with an area of $\frac{1}{15} \times 900 = 60$ square inches will be required. According to Table II, an $8\frac{1}{2}'' \times 13''$ flue must be used for this area. A round flue of $\frac{1}{8} \times 900 = 50$ square inches, or 8 inches in diameter, will be needed.

110. Chimney Caps.—The portion of the chimney projecting above the roof should be laid up in strong cement mortar so as to prevent its disintegration, and should be covered with a protecting cap of stone or concrete. This cap may be pierced with holes to match the flues as shown in (a) in Fig. 49,

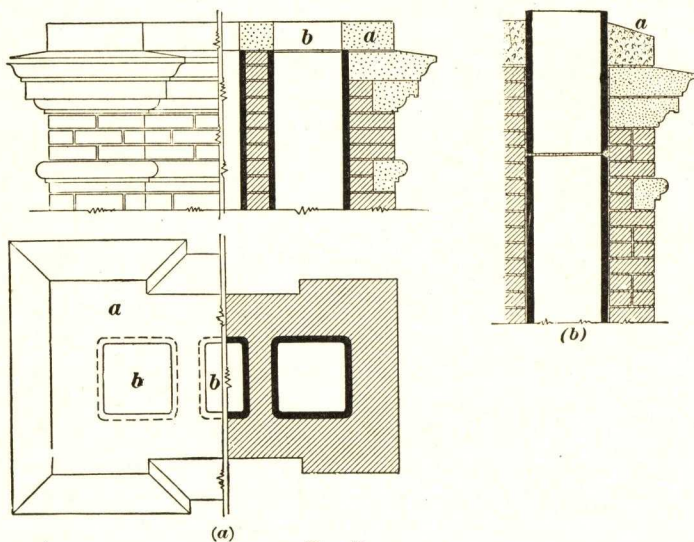


FIG. 49

in which *a* is the capstone of the chimney and *b* the holes cut through flush with the inner edge of the flue lining and covering the joints between the brickwork and the linings. This prevents water from entering the joints of the brickwork, which would soon cause disintegration of the mortar, loosening of the bricks, and discoloration on the exterior of the chimney.

Another method frequently followed is to project the flue lining above the masonry, as in (b), and to build on a concrete or cement cap, *a*. This prevents swirling air-currents, with perhaps accompanying snow flakes, from descending the flue.

It also tends to decrease the erosion under the cap due to water entering the exposed joints in the brickwork. Concrete, however, is more apt to deteriorate under heat, cold and moisture than stone, and thus is likely to prove less durable.

A chimney cap that is not perforated is shown at *a* in Fig. 50. This cap is supported at the four corners by small brick piers between which the smoke passes through the spaces *b*. Such a cap prevents rain and sleet from falling into the chimney.

111. Chimney Pots.—Instead of flat caps, **chimney pots** made of terra cotta are sometimes used. These pots form

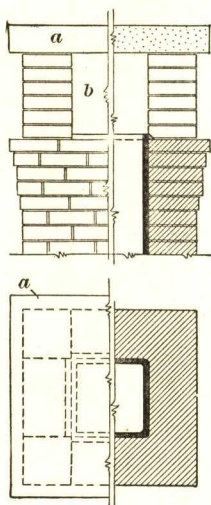


FIG. 50

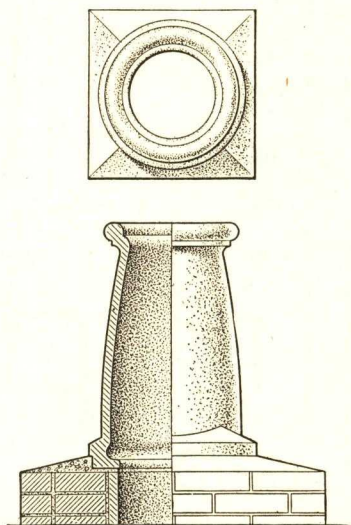


FIG. 51

a picturesque and ornamental finish to a chimney. They are made in many different forms, which are kept in stock by dealers. Examples of terra-cotta chimney pots are given in Figs. 51, 52, and 53 showing half exterior views and sections. The sections show the manner in which the pots are set, so as to cover the flue lining in the chimney. One pot is required for each flue. A strong cement mortar is used in setting the pots and is graded away from the pots to the outside of the chimney so as to form a wash. The design in Fig. 51 is a simple one

with graceful lines and is round or circular in plan. The design in Fig. 52 is more elaborate and is octagonal in plan.

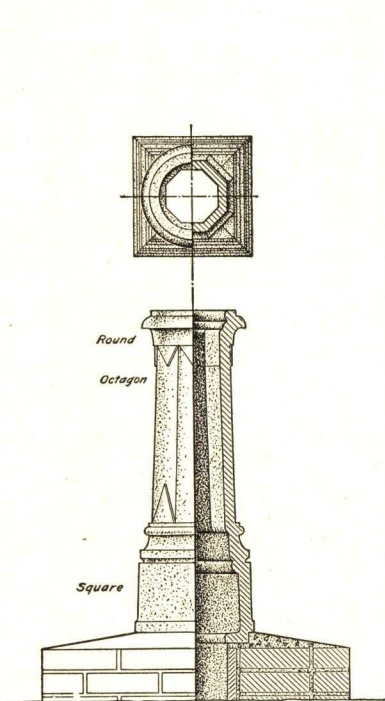


FIG. 52

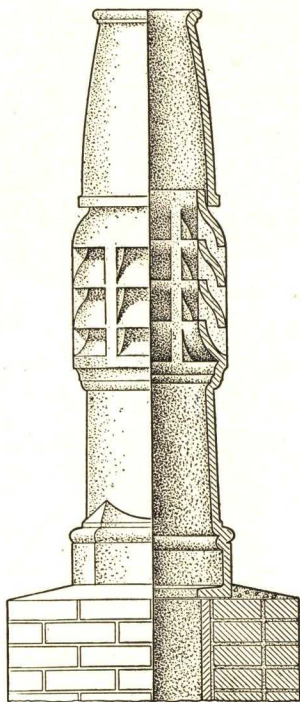


FIG. 53

Fig. 53 is a larger and more elaborate design than the others, with outlets for the smoke in the sides as well as the top.

FIREPLACES

112. Construction of Fireplaces.—The general construction of a fireplace is shown in Fig. 54. The projection of the chimney into the room to enclose the fireplace is called the *chimney breast*. The height of an ordinary fireplace opening should be about 2 feet 6 inches or 2 feet 8 inches above the finished floor, its depth from 16 inches to 24 inches, and its width from 2 feet to 5 feet. If the height of the opening is

made more than 2 feet 8 inches the flue should be made of such a size that the upward draft will be strong enough to prevent smoke coming out into the room.

While a good fireplace can be made that is rectangular in plan, it is better to slope the sides and back as shown in the

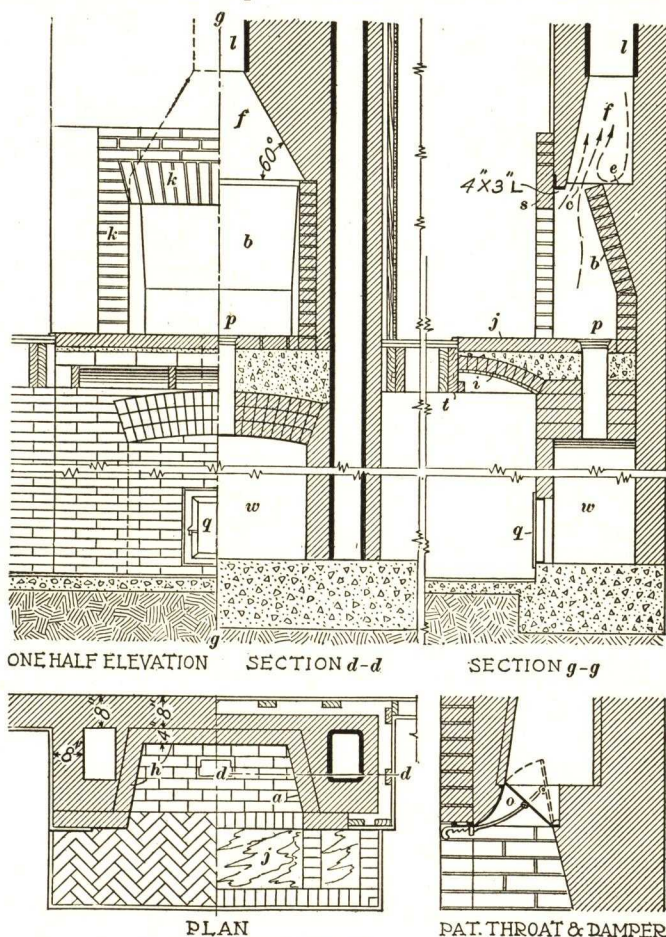


FIG. 54

figure, as these sloping surfaces throw the heat into the room. A slope of about 3 inches in 1 foot, as shown in the plan, is satisfactory.

The *back b* of the fireplace should slope forward and form the *throat c*, which should be from $2\frac{1}{2}$ inches to 4 inches in depth and the full width of the fireplace opening. The total area of the throat should be not less than the area of the flue lining. The throat should be, at least, 2 inches or 3 inches above the top of the opening of the fireplace as shown at *s* and as near the front of the fireplace as possible. Backs may also be curved, as illustrated in fireplace *c* in Fig. 48.

A *smoke shelf e*, Fig. 54, is an important feature. It prevents the air from rushing down the flue when a fire is started and forcing smoke into the room. The *smoke chamber f* is formed by drawing the brickwork together at an angle of 60° on the sides until it is reduced to the dimensions of the flue lining. The bricks should be clipped so as to present as smooth a surface as possible and not a series of offsets. The lining *l* is then started, being supported by the brickwork, as shown. The hearth shown at *j* is extended in front of the fireplace so as to catch embers that may fall out of the fire. It is supported on a trimmer arch *i*, consisting of a single rowlock arch about 20 inches wide springing from the chimney to the header *t*. This arch is laid upon a wooden center which is sometimes left in place, but is liable to be set on fire by a very hot fire on the hearth above. A better practice is to remove the centering of the trimmer arch and cover the space with metal furring and metal lath, to which the plastering may be applied. Upon the trimmer arch, the hearth is built up of cement or concrete and is finished in tile, marble, or brick. The hearth should extend at least 12 inches on each side of the fireplace opening. In Fig. 48 is shown another design for a hearth in fireplaces *b* and *c*. This design is built of reinforced concrete which is cast partly upon wooden forms and partly upon the masonry of the chimney. Iron rods are placed as shown and the concrete is poured so as to surround them. This construction forms a solid slab upon which the finish of the hearth is placed. This finish may consist of brick, tile, or cement.

113. Finish of Fireplaces.—The fireplace shown in Fig. 54 is lined with firebrick or good hard-burned brick. A

loose grate in which coal may be burned is sometimes placed in a brick opening. In some cases ornamental sheet-iron or cast-iron linings are placed in the fireplace as shown in Fig. 55.

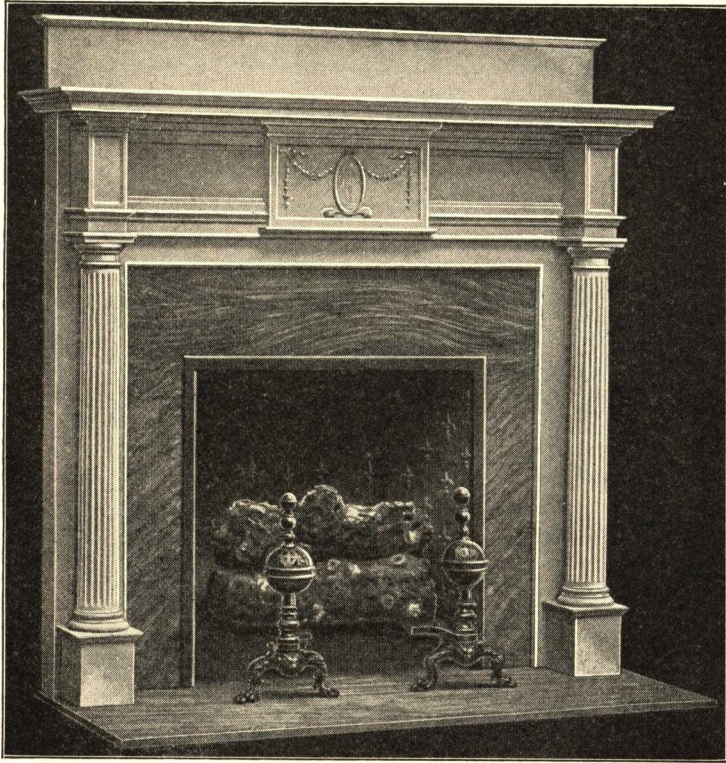


FIG. 55

In this case a hard-burned common brick or else firebrick may be used in constructing the fireplace, as the lining will cover this work.

114. Patent Throats and Dampers.—As it is desirable at times to reduce the draft in a fireplace, a damper should be provided that will permit of partially or entirely closing the throat of the fireplace. There are several patent dampers on the market that are designed to be built in at the top of the

fireplace for this purpose. An example of such a damper is shown in Fig. 54, which shows by solid lines the position of the damper when closed and the position when open by dotted lines. Above this damper a patent throat is sometimes used and is made of concrete or of terra cotta similar to the flue linings. This throat forms the sloping smoke chamber that would otherwise be made in brickwork.

115. Ash Doors and Pits.—When possible, it is very desirable to have an ash door in the hearth under a grate through which ashes may be dropped into a suitable space in the cellar portion of the chimney. This arrangement is shown in Fig. 54, where the ash door is at *p* and the pit at *w*. A door *q* is provided at the bottom of the ash-pit through which the ashes may be removed from time to time. A similar arrangement is illustrated in Fig. 48.

FACE AND ORNAMENTAL BRICKWORK

Serial 1832

Edition 1

INTRODUCTION

1. Use of Brick.—Brick is one of the most useful of all building materials as well as one with which highly artistic effects can be obtained. Its use for utilitarian purposes, such as building walls and piers, will be considered in the Section entitled *Common Brickwork*. Its possibilities as a decorative material will be discussed in the following pages.

2. Brick as a Decorative Material.—Brick can be used ornamentally or decoratively in two different ways. One way is by laying it so as to form patterns on the surface of walls and piers by the use of different sizes, colors, and surface textures, also by using mortar of varying color and texture and by using mortar joints of different thicknesses. This method of producing attractive and artistic effects in brickwork will be discussed under the heading of Face Brickwork. An example of artistic face brickwork is shown in Fig. 1.

3. Brick can also be used as relief ornament in the form of string-courses, cornices, brackets, etc., which project beyond the face of the wall, as shown in Figs. 2, 6, and 7. Brickwork of this description will be referred to as Ornamental Brickwork.

4. Combinations of Face and Ornamental Brickwork.—Combinations of these methods of using brick have been employed with charming results, as shown in Fig. 2. This

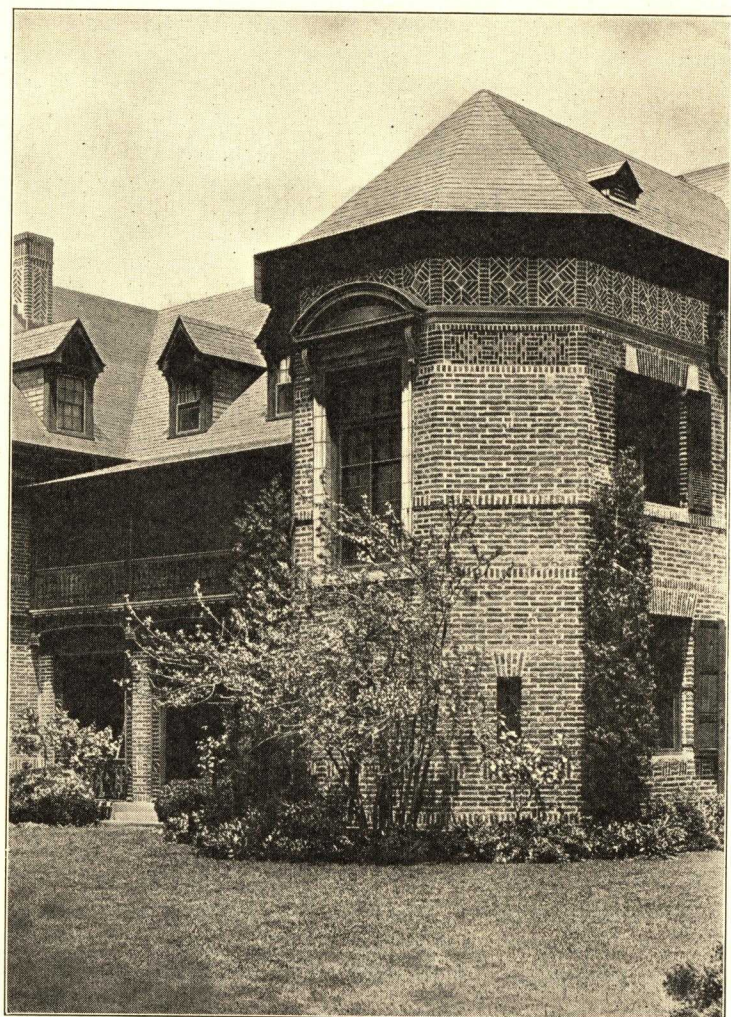


FIG. 1

building is a dove-cote, or pigeon coop, at the Manoir D'Angot in France and was built in the 16th century. This example illustrates the use of *ornamental brickwork* in the projecting



FIG. 2

cornice as well as of *face brickwork* in the patterned surface of the wall. In this building, small blocks of stone have been used in connection with brick to produce contrast in texture and color in the patterns.

4 FACE AND ORNAMENTAL BRICKWORK

5. At the present day architects and builders have at their disposal a wealth of material in the form of bricks of different sizes, shapes, colors, and textures, as well as tiles of all colors, which afford excellent opportunities for designing walls of artistic excellence. An example of such a wall is given in Fig. 1.

DEFINITIONS

6. As there are a number of terms used in connection with brickwork that will be used frequently in connection with the following descriptions, definitions of these terms are here given.

In referring to the individual bricks, the different faces of the brick will be referred to as follows and as illustrated in Fig. 3.

The **top** is the upper large surface.

The **bottom** is the lower large surface.

The **face** is the long narrow side or edge that shows in the face of the wall.

The **back** is the long narrow side or edge opposite the face.

The **heads** are the small ends of the brick.

A **unit** is one brick or piece of brick used in a pattern or a bond.

A **stretcher** is a brick that is laid on its bottom with its face showing in the face of the wall, or a brick whose length extends in the direction of the wall, as shown in Fig. 4 at *a*.

A **header** is a brick laid on its bottom with the head showing in the face of the wall, as at *b*.

A **bull header** is a brick laid on its face or back and showing a head in the face of the wall, as at *c*.

A **course** of brick is one horizontal row of bricks, as at *e*.

A **stretcher course** is one row of *stretchers*, as at *d*.

A **header course** is one row of *headers*, as at *e*.

A **rowlock**, or **rollock**, **course**, is a row of *rowlocks*, or *bull headers*, as shown at *f*.

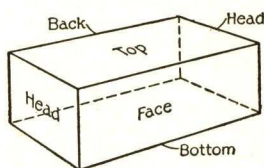


FIG. 3

A **soldier course** is a row of bricks with the faces laid vertically, as shown at *g*.

A **string-course** is a horizontal course continued across the face of a building. It generally projects and may be flat, molded, or carved.

A **herring-bone pattern**, shown at *h*, consists of bricks laid diagonally in opposite directions.

Bond is the arrangement of the bricks in the wall by which the wall is tied, or bonded, together. This bonding is accomplished by lapping each brick over two or more bricks below it.

Face bond is a bond, or pattern, which shows on the face of the wall but is not generally carried through the entire thick-

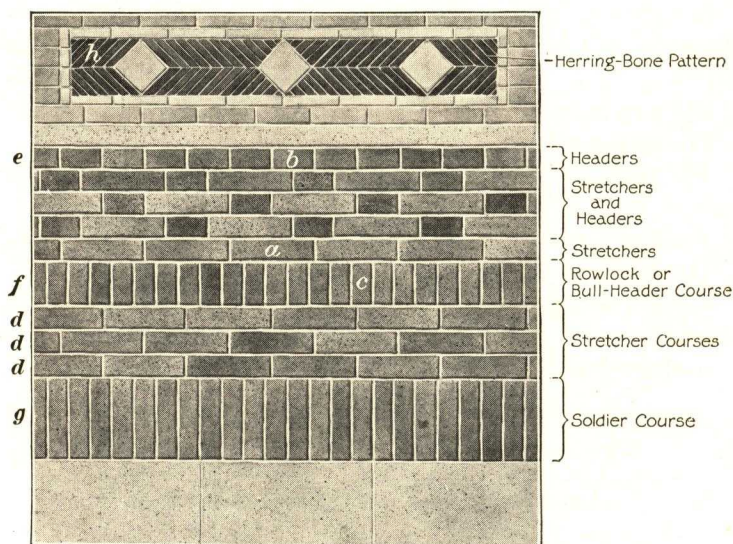


FIG. 4

ness of the wall. The substantial body of the wall may be built in some strong bond that is economical to build, while the face of the wall may be finished in a more elaborate and totally different bond. This ornamental facing of brick must be securely fastened to the wall back of it, upon which it depends for support. The substantial wall to which the facing is attached, or bonded, is often referred to as the **backing**.

6 FACE AND ORNAMENTAL BRICKWORK

The **brick field** is the brick surface of the wall.

Breaking joints is the arrangement of the joints of the brickwork so that the vertical joints in one course shall not come directly above the vertical joints in the course below.

A **blind joint** is a joint between two bricks that is made as thin and inconspicuous as possible so as scarcely to be noticeable.

BRIEF HISTORY OF BRICKWORK

7. Brick architecture has naturally developed in countries or parts of countries where there was an abundance of clay from which bricks could be made, and where there was a scarcity of wood and stone. Thus, in ancient Babylonia, most of the building of importance was done with clay products such as brick. Some of these bricks were merely dried in the sun,

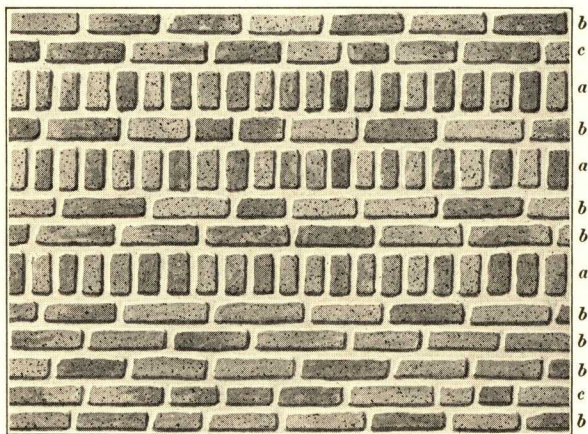


FIG. 5

and are known as *sun-dried* bricks, while some of them were baked in kilns as is done at the present day. A few examples of typical brickwork of various countries, both ancient and modern, will now be described and shown.

8. **Egypt.**—Brickwork found in ancient Egyptian tombs is illustrated in Fig. 5, which shows an example from the tomb

of Mersekha, built about the year 2900 B. C. This brickwork shows a pattern, or bond, which consists of rows of headers *a* separated by rows of stretchers *b*. The headers are bull

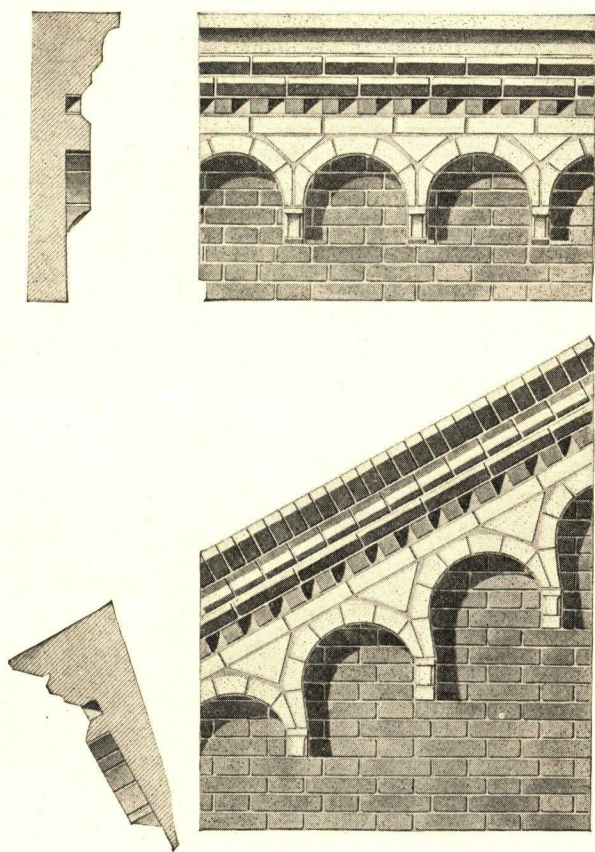


FIG. 6

headers. The bricks are roughly molded and irregular in size. Headers are introduced occasionally in the rows of stretchers, as shown at *c*. A number of the well-known Egyptian pyramids were built of brick.

9. Ancient Rome.—The Romans used brick extensively. The bricks themselves were always flat, varying from $\frac{1}{2}$ inch

8 FACE AND ORNAMENTAL BRICKWORK

to 2 inches in thickness. In the Baths of Titus, erected about 80 A. D., the bricks were about 18 inches by 6 inches by 2 inches in size. Bricks found in remains of Roman structures in England are dark red and light red in color, these colors being used together in the walls. These bricks were laid with wide mortar

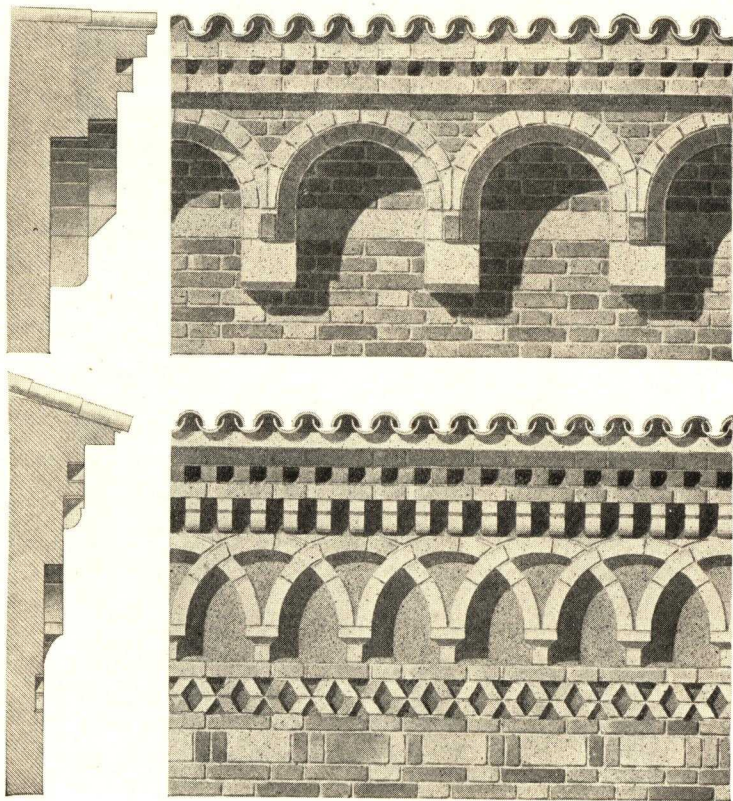


FIG. 7

joints, and the mortar used was generally composed of lime mixed with broken tiles, sand, and gravel more or less coarse in size.

Excellent examples of Roman brickwork have been found in England. At Caster, an ancient Roman camp, a fine example of herring-bone masonry was found. Another example exists in St. Botolph's Priory near Colchester.

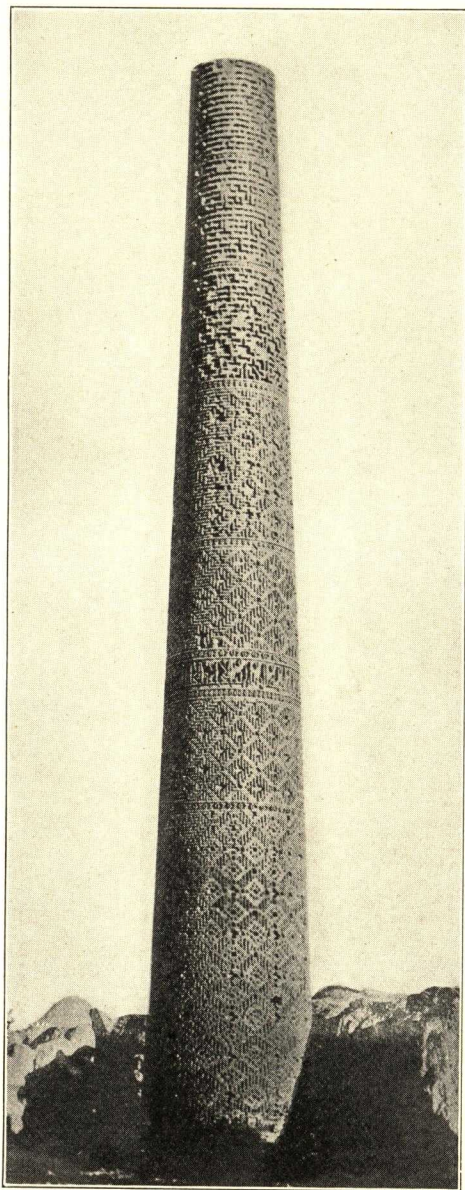


FIG. 8

10. Italy. — In Italy during the Middle Ages, especially in the cities of the North, brick architecture reached great perfection in its application to churches and civic buildings. Brick was used in connection with terra cotta and stone, and ornamental brickwork of the highest artistic character was used in the cornices of Italian buildings. Examples of these cornices are shown in Figs. 6 and 7. Other examples of Italian brickwork are: Baptistry of St. Stefano, 4th century; St. Agata in Ravenna, 5th century; Cathedral, Cremona, 12th century; Broletto (Town Hall), Brescia, 13th century; San Pietro Ciel D'Oro, Pavia, 13th–15th centuries.

11. Persia. — It was in the 16th century that Persian brickwork reached that degree of excel-

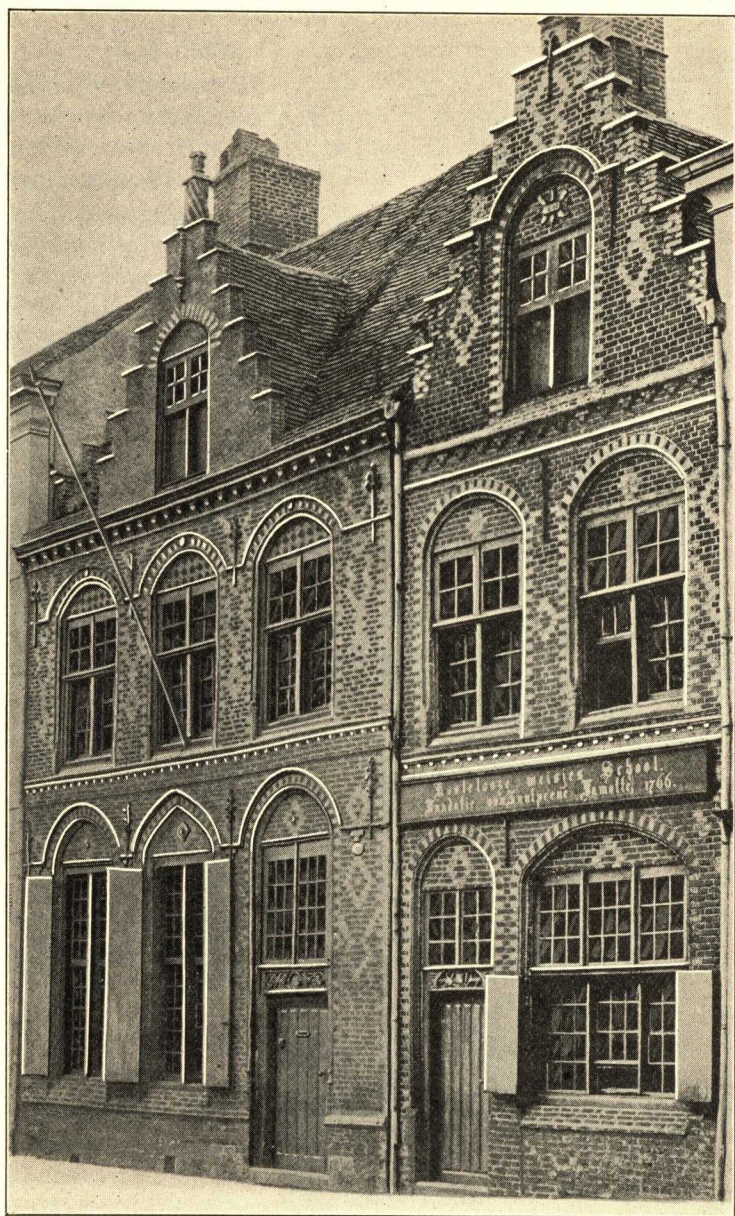


FIG. 9

lency which characterizes so many Persian mosques and mausoleums as masterpieces of the brickbuilder's art and ingenuity. Notwithstanding that brick architecture had been practiced in Persia from the 7th century, it was in the early part of the 16th century that buildings were built that are notable for their workmanship, color, and design. At Bostam, Ispahan, Tebriz, and Ardebil, the mosques and minarets are monuments of the possibilities of brick as a means of decoration. An example of this work is given in Fig. 8. The building shown is a minaret, or prayer tower, connected with the mosque of Tschihil Sutun in Damgan, Persia, and was built in the 16th century.

12. Netherlands.—During the 14th and 15th centuries, the brickbuilders of the Netherlands were not only erecting their homes and public buildings of brick, but were also instructing their neighbors, the English, in the use of brickwork. Their buildings with the quaint *stepped* gables possess great individuality and charm. In Fig. 9 are shown two excellent buildings which were built in Ypres, Belgium. These buildings show the delicacy and refinement with which brick was employed, and also illustrate the formation of patterns by the use of brick of different colors. Molded brick have also been used around the windows and in the string-courses.

Notable examples of brickwork are given in the following list of buildings:

Church of St. Martins, Ypres, Belgium.....	14th century
City Gates, Haarlem, Holland.....	15th century
Tournal House, Holland.....	15th century
St. Jean Hospital, Hoorn, Holland.....	16th century
Convent des Celestines, Tournal, Holland..	16th century

13. England.—The earliest brick building existing in England is Little Wenham Hall in Lincolnshire, which was built in 1260. By the year 1300, brickwork was in general use in England. The great manor houses of England were erected in the 15th and 16th centuries, as shown by the following list of such buildings:

12 FACE AND ORNAMENTAL BRICKWORK

	ERECTED
Hurstmanceaux Castle	1440
Tattershall Castle	1440
Rye House (Hertfordshire).....	1440
Lollard's Tower (Lambeth Palace).....	1454
Layer Marney Towers	1500
Sutton Place, Guilford.....	1523
Compton Wynyates	16th century
East Barsham Manor	late 16th century

A portion of the last-mentioned building is shown in Fig. 10.

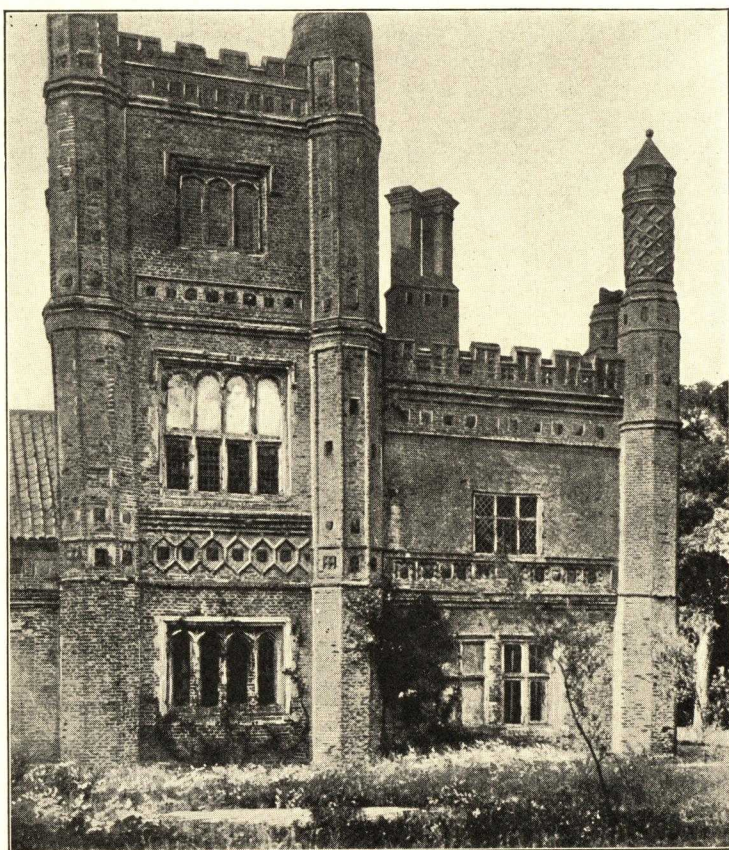


FIG. 10

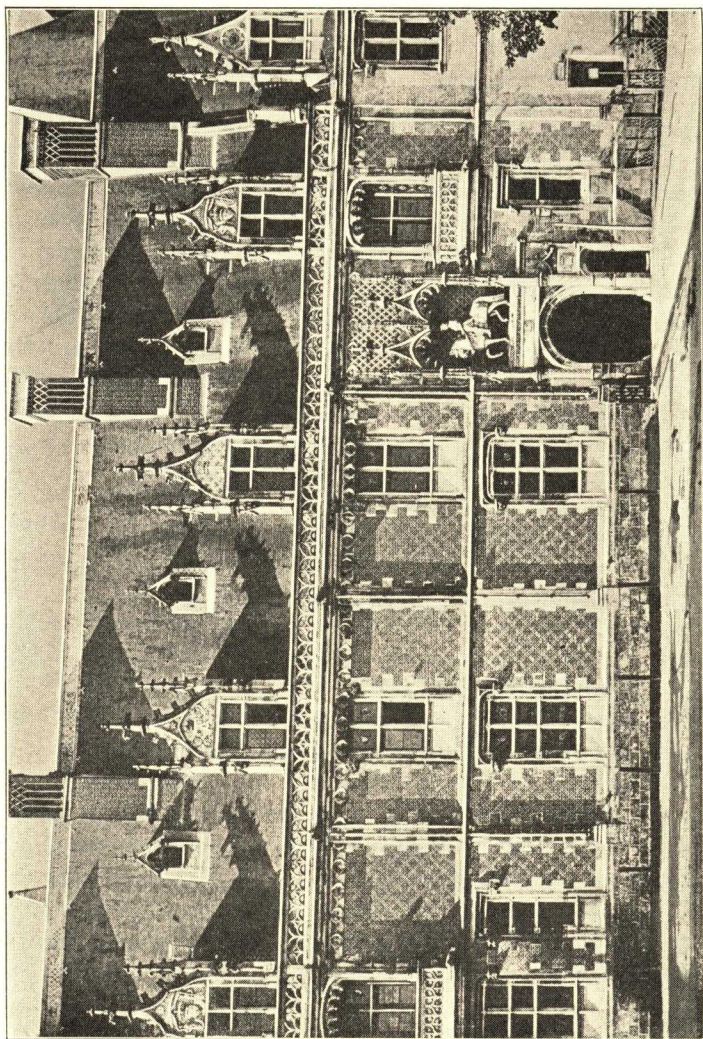


FIG. II

14 FACE AND ORNAMENTAL BRICKWORK

It was undoubtedly from the Flemish brickbuilders of the Netherlands that the English received the incentive to erect the series of magnificent brick buildings that mark the progress of the history of England.

14. France.—The French people used brick with excellent taste but generally used it for wall treatments in which the brickwork was framed by stone. This treatment is shown in the Louis XIII wing of the Château of Blois illustrated in Fig. 11. The brick surface has a crisscross pattern formed by bricks that are lighter in color than the others. A particularly charming example of French brickwork is shown in Fig. 2, which is the dove-cote at the Manoir D'Angot of the 16th century. Other noteworthy examples of brick architecture are the Château de Martainville of the 15th century at Epreville; the Manoir D'Angot itself, and a pigeon house at Boos.

15. America.—In America, during the Colonial period of its history, our architects and builders developed the Colonial Style of Architecture, which was an offshoot of the Georgian style in England. Brick was imported from England and used with considerable taste in some of the colonial houses in the southern colonies, such as Maryland and Virginia. A decline in architectural taste occurred during a great part of the 19th century but a revival, or renaissance, of good taste has been experienced in recent years which gives promise of most satisfactory results.

Many excellent buildings by such architects as H. H. Richardson, McKim, Mead, and White, and by prominent living architects, are fine examples of brickwork. Designers of the present day have the best possible opportunities for producing fine brickwork, as the manufacturers are now making superior grades of brick which offer great varieties of color, size, and texture as well as durability.

FACE BRICKWORK

DESCRIPTION OF FACE BRICK

BRICK SHAPES AND SIZES

16. The sizes of brick units varied in past ages, according to the locality in which they were produced and the use to which they were to be put, just as they do today. In an ancient Sargonic arch, made about the year 4000 B. C., the bricks measure 12 inches by $2\frac{1}{2}$ inches by 6 inches. Ancient Babylonian brick measured 12 inches by $5\frac{1}{8}$ inches by $2\frac{1}{4}$ inches. Other Babylonian bricks measured $8\frac{5}{8}$ inches by 2 inches by $4\frac{1}{8}$ inches, which are similar in size to bricks made at the present time.

The Roman bricks, as has been stated, were made 18 inches by 6 inches by 2 inches in size.

17. Brick Sizes as Used in the United States.—The standard sizes of brick in the United States are those adopted by the National Brickmakers' Association. For common brick the standard size is $8\frac{1}{4}$ in. $\times$ 4 in. $\times$ $2\frac{1}{4}$ in.; for face brick, $8\frac{3}{8}$ in. $\times$ $4\frac{1}{8}$ in. $\times$ $2\frac{1}{4}$ in.

The brick manufacturers, in making standard brick, only approximate these sizes, as it is impossible to regulate absolutely the amount of shrinkage that will take place between the time the brick is molded and the time it is thoroughly burned. Differences in size are almost invariably found in the same shipment of brick.

It is customary, especially when a fine joint is to be used, to sort out these face brick and place all the bricks of the same size in one pile and those of other sizes in other piles. These different sizes are used in different portions of the wall so that the difference in size is not noticeable.

In some cases the manufacturers make bricks that vary considerably in size from the standard brick. It is therefore advisable, before laying out the drawings for the front of a building that is to be faced with face brick, to obtain by actual measurement the exact size of the bricks that it is desired to use, so as to make the openings in the wall, especially the heights, of sizes that are multiples of the brick size. It is also necessary to know the exact size of the bricks to be used when stone or terra cotta are used in connection with the face brick, to make the heights of the stone or terra-cotta courses equal in height to a given number of brick courses so that the horizontal joints shall coincide.

18. Sizes of Standardized Brick.—There are a number of other standardized sizes of face brick, the names and the approximate sizes of which are given herewith. These sizes are obtained from catalogs of prominent manufacturers and show the variations in sizes which are sold under the same name.

NAMES AND SIZES OF FACE BRICK

NAMES OF BRICK	APPROXIMATE SIZE	
	INCHES	
Real Roman	{	18 × 2 × 6
		$17\frac{1}{2} \times 11\frac{1}{2} \times 5\frac{1}{2}$
		$18 \times 1\frac{1}{2} \times 6$
Norman	{	12 × 2 $\frac{1}{2}$ × 4
		$11\frac{7}{8} \times 2\frac{1}{4} \times 4$
Roman	{	12 × 1 $\frac{1}{2}$ × 4
		$11\frac{1}{2} \times 1\frac{3}{4} \times 4$
		$11\frac{5}{8} \times 1\frac{5}{8} \times 3\frac{7}{8}$
English	{	$8\frac{7}{8} \times 2\frac{7}{8} \times 4\frac{3}{8}$
		$7\frac{3}{4} \times 2\frac{1}{2} \times 3\frac{1}{2}$
Standard	{	* $8\frac{3}{8} \times 2\frac{1}{4} \times 4\frac{1}{8}$
		$8 \times 2\frac{1}{4} \times 3\frac{3}{4}$
		$8\frac{1}{4} \times 2\frac{1}{4} \times 4$
		$8\frac{1}{8} \times 2\frac{3}{8} \times 4$
Split		8 × 1 $\frac{1}{8}$ × 4
Pony		6 × 1 × 2 $\frac{3}{4}$

* Standard recommended by National Brickmakers' Association.

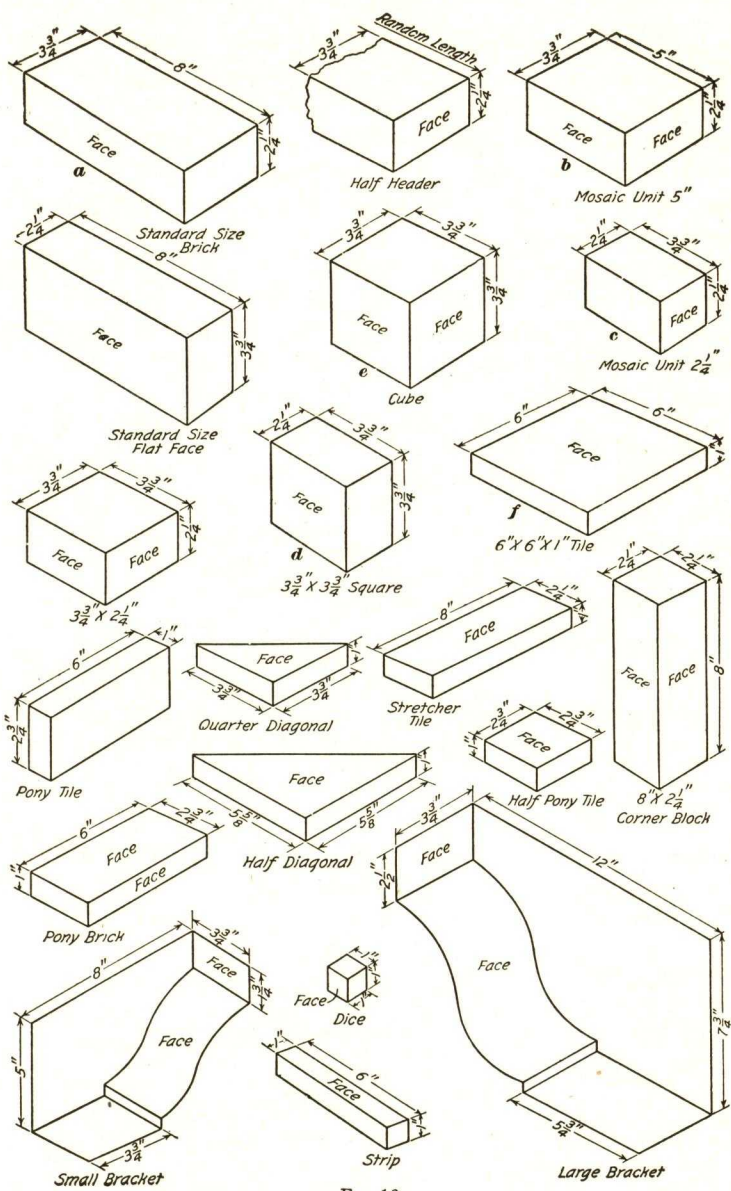


FIG. 12

19. Special Shapes.—Besides these standardized sizes and shapes, there are many special shapes made for use in pattern work. Some of these special shapes are shown in Fig. 12. The sizes of these units are marked in the illustration.

By using the standard-sized brick *a* with the 5-inch unit *b* and the $2\frac{1}{4}$ -inch unit *c*, reproductions of the interesting Persian pattern work such as shown in Fig. 59 can be made.

The square piece *d*, measuring $3\frac{3}{4}$ inches by $3\frac{3}{4}$ inches, is used in turning the corner of a border of bull-headers, or rollocks, as shown at *a* in the panel in Fig. 60. The cube *e*, Fig. 12, is used in turning the projecting corner in a course of rollocks, as shown in the upper corners of the brick flower boxes in Fig. 49. The square brick or tile *f*, Fig. 12, 6 in. $\times$ 6 in. $\times$ 1 in. in size, is used in positions such as shown in the ornamental bands at the tops of the bay windows in Fig. 63.

These special shapes save the mason a great deal of cutting and insure better results in laying out the work; also, they can be used in different colors than those used in the field so as to produce contrasts both in form and color.

20. Tile.—Tile are made of clay similar to that of which face brick are made and have, to a large extent, the same texture and coloring. Enameled and decorated tile are made in numerous shapes, colors, and designs. Patterns made of tiles are often used very effectively in connection with brickwork.

These tile are manufactured of the sizes and surfaces given in the accompanying list:

SIZES AND SURFACES OF TILE	
SIZE. INCHES	SURFACE
12 $\times$ 12 $\times$ 1	Smooth
9 $\times$ 9 $\times$ 1	Smooth
9 $\times$ 6 $\times$ 1	Smooth
8 $\times$ 8 $\times$ 2	Rough and semismooth
6 $\times$ 6 $\times$ 1	Rough, smooth, and semismooth
6 $\times$ $2\frac{3}{4}$ $\times$ 1	Rough and semismooth
4 $\times$ 4 $\times$ 1	Smooth
$2\frac{3}{4}$ $\times$ $2\frac{3}{4}$ $\times$ 1	Rough and semismooth
Half diagonal of a 6" $\times$ 6"	Rough and semismooth
Quarter diagonal of a 6" $\times$ 6" ..	Rough and semismooth

The rough tile has a decidedly rough texture on its face and is used for the floors of porches and terrace walks as well as for wall decoration in connection with rough-textured brick.

BRICK TEXTURES

21. Rough Textures.—A rough texture is commonly produced by mixing a coarse material such as grit or small



FIG. 13

pebbles with the clay, or by cutting the brick with wires when molding it, or by both methods. Fig. 13 shows a brick that is artificially roughened by the introduction of grit and pebbles in the clay. Another example of a brick surface containing pebbles is shown in Fig. 14.

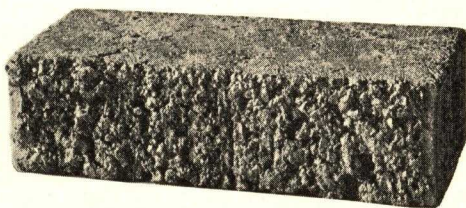


FIG. 14

The surfaces are also roughened by cutting the brick, when molding it, with wires, which drag and tear the soft clay surface, as shown in Figs. 15 and 16. Such brick is called *wire-*

cut brick. When the wire cuts the brick from one end to the other a surface is produced such as is shown in Fig. 15. This



FIG. 15

brick is called an *end-cut* brick. When the wire is drawn from one long edge to the other, a surface like that shown in Fig. 16 is produced. This brick is a *side-cut* brick. The

brick shown in Fig. 13 has been roughened not only by the use of a coarse ingredient in the clay but by a subsequent scratching which produced the vertical marks shown on some of the bricks. Figs. 15 and 16 show a brick with a medium-rough surface.

An example of a rough brick surface, which is due to irregularity in burning during the processes of manufacture, is shown in *clinker* brick which has been cracked and twisted out of shape by the flames in the kiln. This brick, which in the past was generally sent to the rubbish heap, when used with taste and skill forms an artistic wall surface that possesses character and interest. A portion of a wall built of clinker brick is shown in Fig. 17.

22. Smooth Textures.—A smooth brick may be either a *pressed* brick, which is pressed by machinery into an accurate shape with edges absolutely true, or a *wire-cut* brick, which has the largest surfaces cut by the wires of the brick-cutting machine, while the other faces are all perfectly smooth. The edges of a wire-cut smooth brick are not as true as those of a pressed brick and consequently the brick when set has not that mechanical appearance which is characteristic of pressed-brick work.

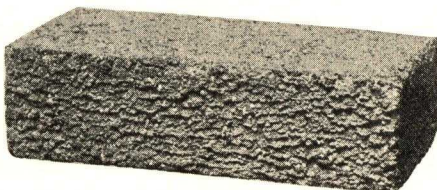


FIG. 16

An example of a wall laid up with a smooth-textured brick is shown in Fig. 18.

23. Effect of Texture.—A wall built of bricks that are perfect in shape, absolutely smooth, uniform in color, and laid up with fine even joints, is not only very expensive to build but is very mechanical and inartistic in appearance. This fact is appreciated by architects and designers, and the best modern brickwork is constructed with brick which has more or less roughness of surface and variety of color, and of which the individual bricks are not mechanically perfect in form. With

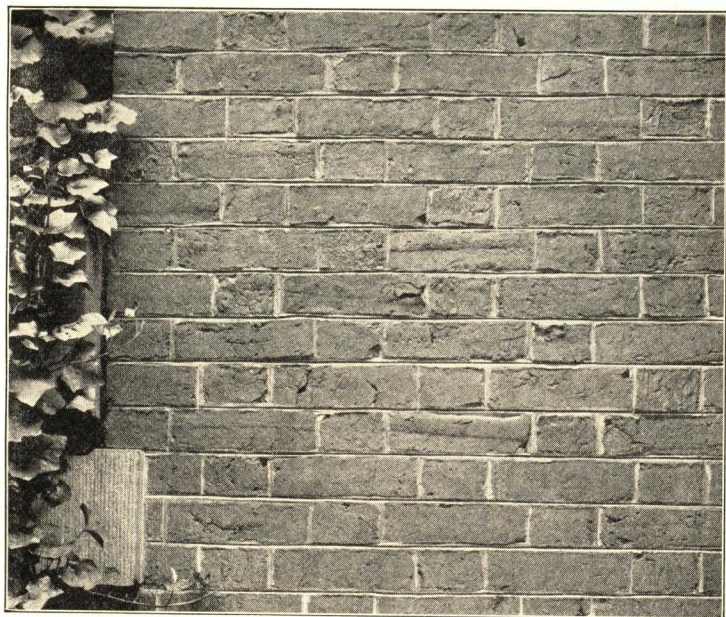


FIG. 17

brick of this description, properly selected and laid, a wall can be laid that will have character, brilliancy, and interest. Such a wall will not appear hard and set; the color will not be monotonous, and the surface having some texture will give a play of light and shadow that will enliven the appearance of the wall and add brilliancy to the color.

By using some of the rougher-textured brick, new brickwork can be built so as to have a great deal of the charm of ancient work which is so much admired. One of the greatest charms

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of the brickwork of the old colonial houses lies in the slightly rough texture and the soft color tones of the brick units.

24. At a distance from the building, the particular texture of the brick units is lost, but the effect of the rougher textures



FIG. 18

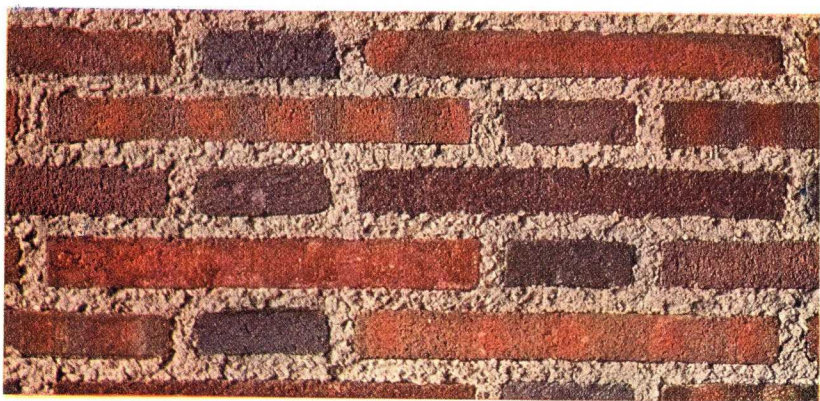
is to soften the color of the mass of the brickwork and to do away with the glare which often occurs when the brick units are very smooth in texture.

25. Modern face bricks are generally burned so that they are almost vitrified and will not absorb moisture. Dust from the atmosphere which may lodge on the rough surface of the brick will therefore not be absorbed but will be washed off by rain, thus leaving the color of the brick fresh and clear.

BRICK COLORS

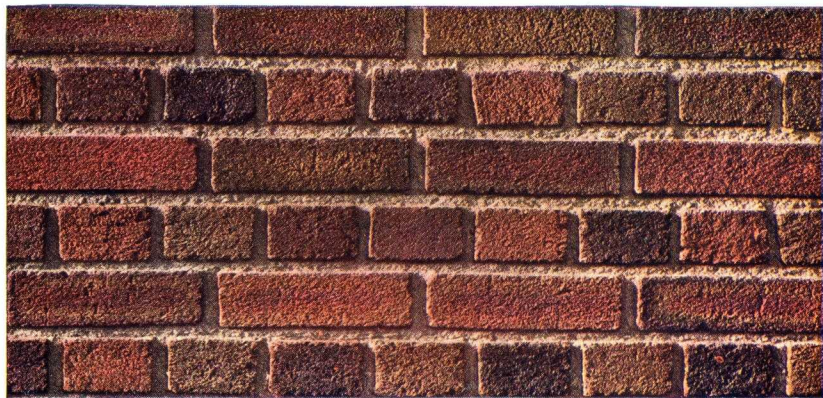
26. Causes and Varieties of Brick Colors.—Bricks in the United States and in Europe are naturally red in color, although, in some parts of the United States, clay is found that produces a yellow-colored brick. The bricks made in China and Japan are generally of a slaty-blue color.





By courtesy of Fiske & Co., Inc.

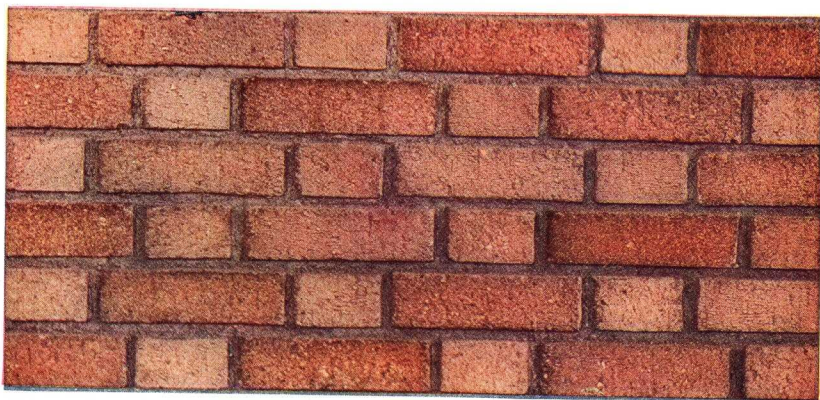
FIG. 19



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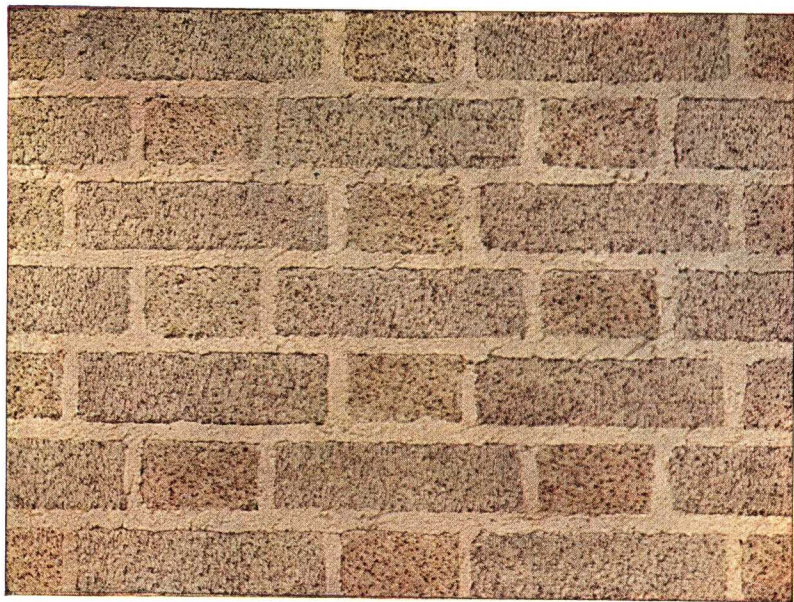
FIG. 20

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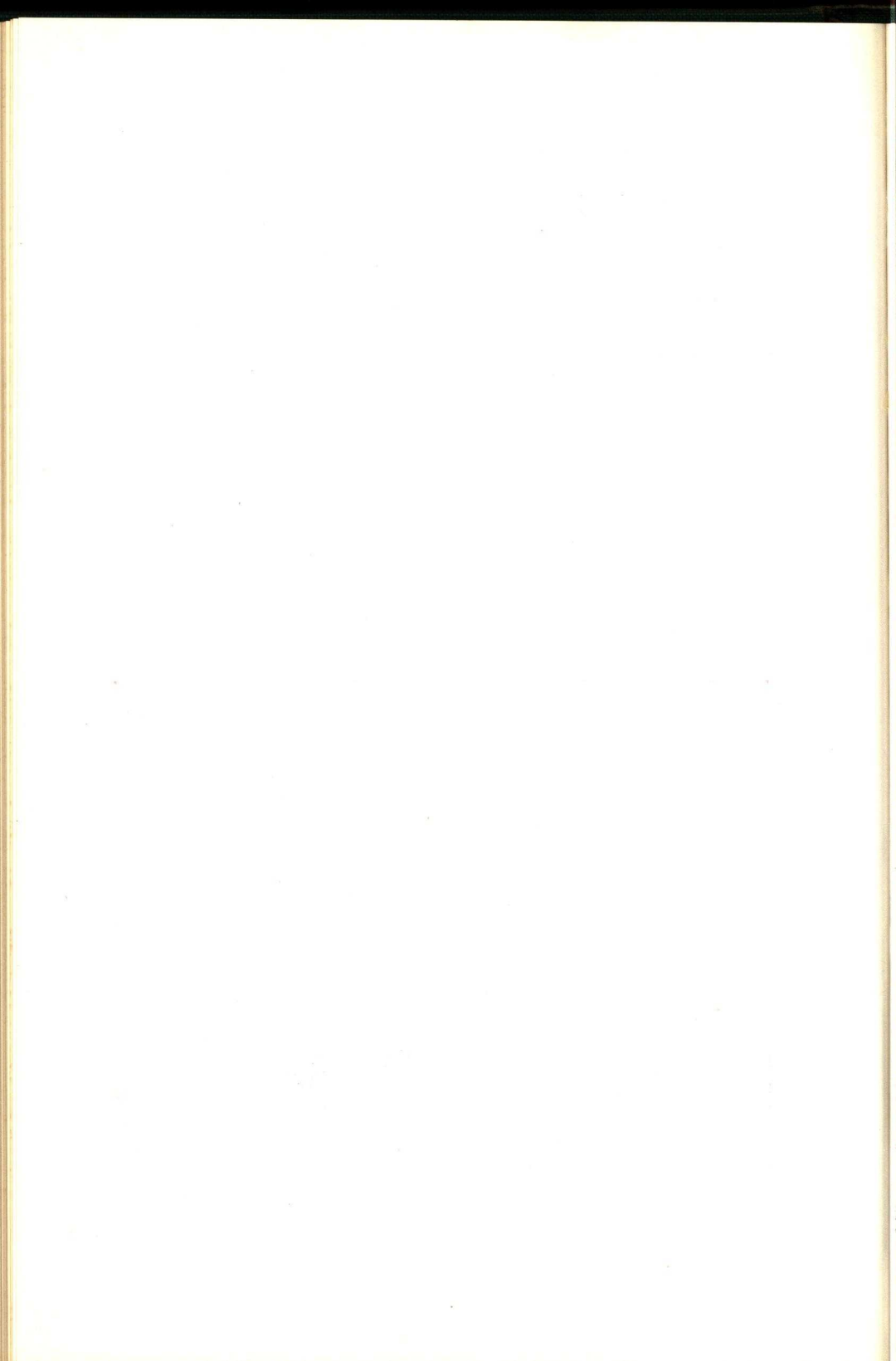
FIG. 21

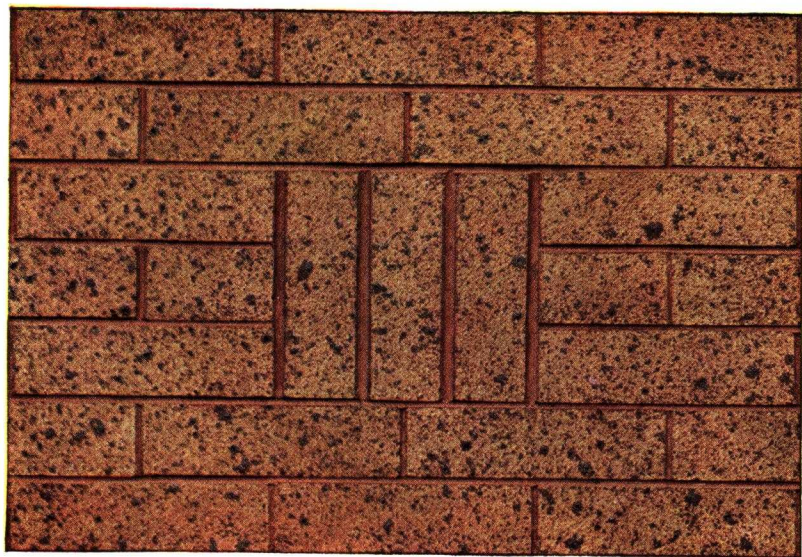


By courtesy of Hydraulic-Press Brick Co.

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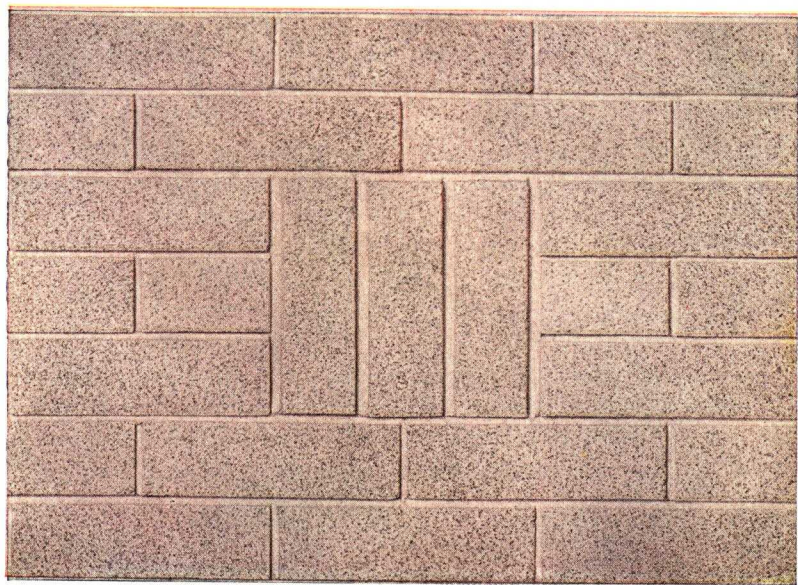
FIG. 22





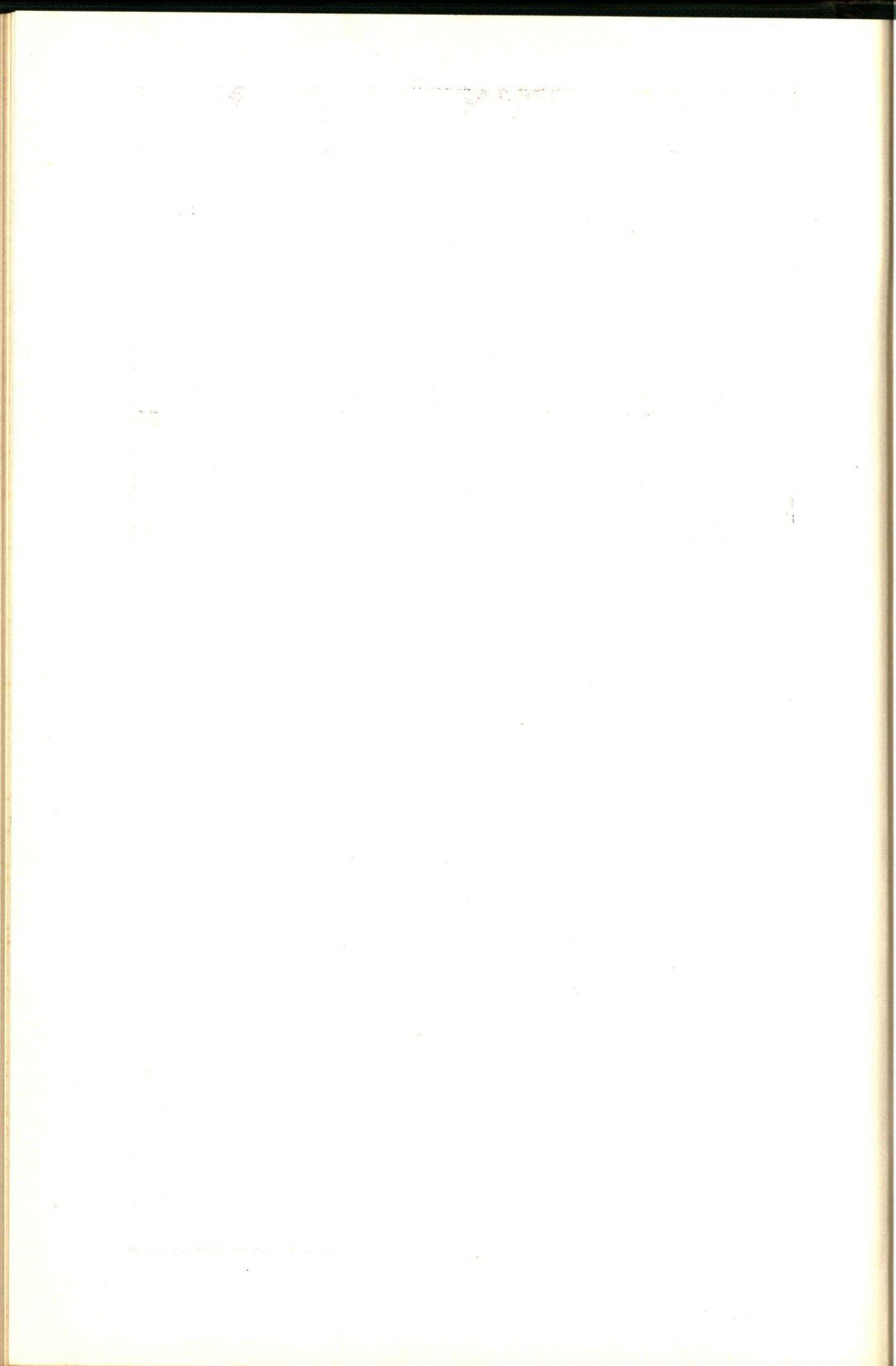
By courtesy of Hydraulic-Press Brick Co.

FIG. 23



By courtesy of Hydraulic-Press Brick Co.

FIG. 24



The presence of iron, magnesia, lime, and other materials in the clay causes the different colorings in the finished brick. Iron in the clay will produce such colors in the brick as light yellow, orange, red, dark blue, and purple, according to the amount of iron present in the clay and the heat at which it is burned. Magnesia gives a brown color; magnesia and iron together, a yellow color; lime and iron together, a drab color.

Different clays contain these elements naturally, and by skillfully mixing selected clays, bricks can be made in a large variety of colors without the use of artificial coloring materials.

The degree of heat at which the bricks are burned has a great effect upon the color of the brick. This is well illustrated in the case of common bricks, which are taken from the old-style kiln with colors varying from a light salmon color to dark blue, according to the amount of heat to which they have been subjected.

The colors in which modern bricks are made are *reds*, varying from light pink to deep red; *buffs*, varying from a light cream color to deep, rich browns; *browns*, which vary from a light brown to a dark brown. There are also blues, purples, greens, and various fancy colors. Examples of some of these colors are shown in the colored illustrations in this Section.

There are generally variations in the face color of the same brick which give an interesting appearance to the individual bricks and also to the brick field. Such brick is shown in Figs. 19, 20, 21, and 22.

The bricks sometimes have iron spots on the surface, as shown in Figs. 23 and 38, or mottles, as shown in Figs. 24 and 29. The surface is sometimes glazed. In short, there is a great variety of texture and color from which the architect may choose, and the success of the choice will depend upon his taste and experience.

27. Judging Effects.—The color or texture of the completed wall can never be correctly judged from the color or texture of a single brick or even from a number of bricks laid up, as the atmosphere and the distance of the wall surface from the eye greatly affect the appearance of the brick. The

best way to judge the effect of a given brick in a building is to see a building built of the same kind of brick, which often can be done.

When a wall of the desired brick cannot be seen, a small sample wall of the chosen brick and mortar is laid up with a certain bond and width of joint. If this sample wall is satisfactory, the combination is adopted and used. If, however, the sample does not meet with approval, other bricks, mortar, joints, and bonds are tried by building small sections of wall until a satisfactory combination is discovered.

In the show rooms of brick dealers, a variety of such sample walls can generally be seen, which will assist the architect and the client in selecting a satisfactory combination.

MOLDED BRICK

28. Ornamental brickwork may be formed of plain brick which is built so as to project and form cornices and

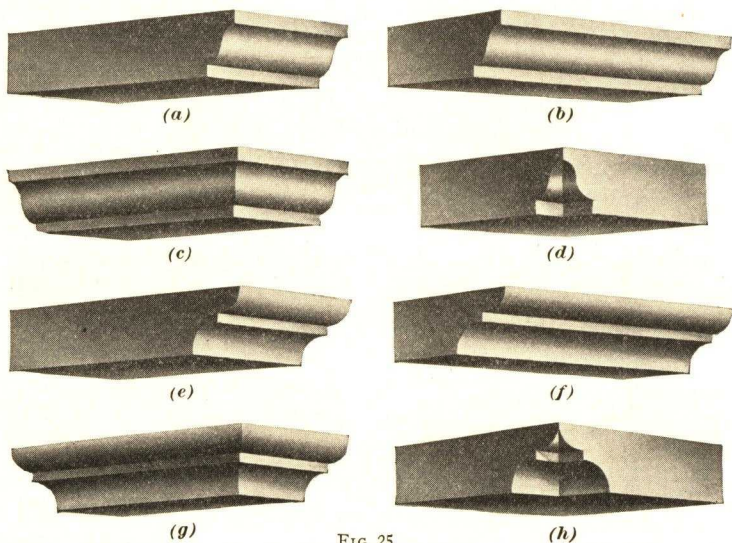


FIG. 25

string-courses in the manner shown in Figs. 2, 6, and 7, or by the use of bricks which are molded into various shapes.

These bricks are made in a large variety of shapes so that many architectural details such as cornices, string-courses, panels, window sills, columns, and pilasters can be made of them.

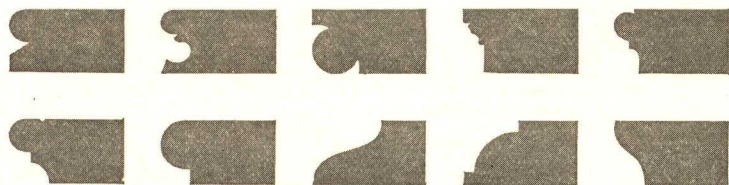


FIG. 26

The projection of molded brick details must necessarily be small, but several courses of brick can be projected over each other so as to produce a satisfactory total projection in the entire cornice.

The units in which molded brick is made are of such a size that they can readily be laid up with standard face brick and the horizontal joints can be maintained at each course or two.

Some of the more common and useful shapes that are made in molded brick are shown in Fig. 25. In (a) is shown a mold-

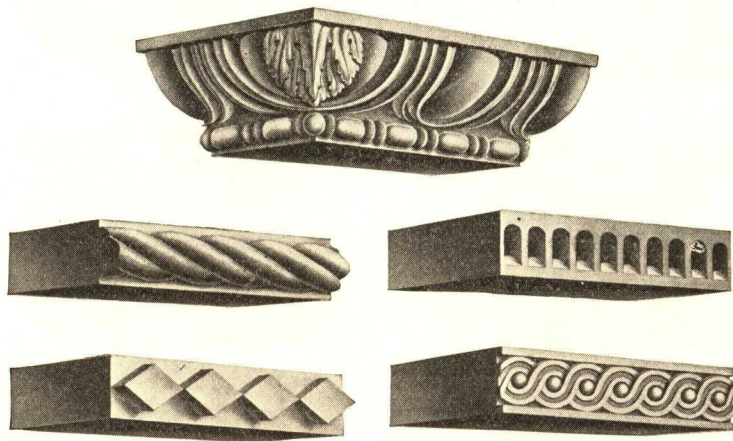


FIG. 27

ing known as a *cyma recta*, or crown, molding. These bricks are generally made in four forms to fit them for use in a string-course. A header for this molding is shown in (a); in (b) is a stretcher, in (c) a projecting corner, and in (d) a sunk corner.

In *e*, *f*, *g*, and *h* are shown the four molded bricks required for another form of crown molding, called a *cyma reversa*.

Several profiles of molded brick commonly used are given in Fig. 26. The necessary headers, stretchers, and corners are also made for these moldings.

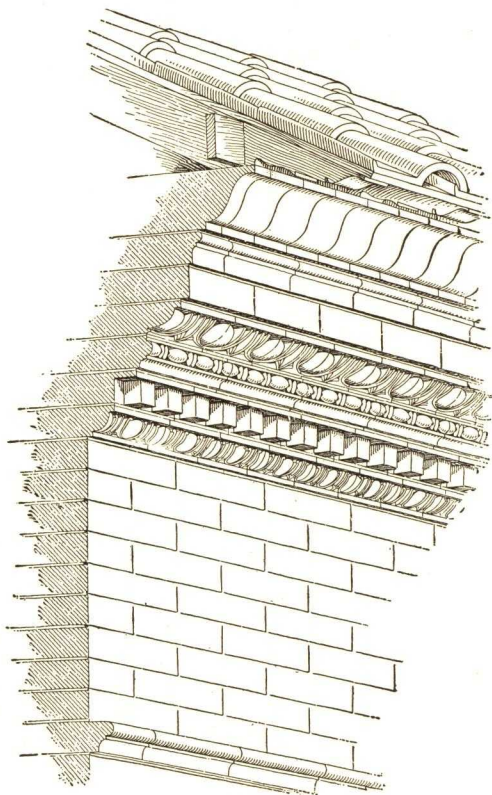


FIG. 28

Ornamental band courses having ornament in relief or projection are shown in Fig. 27.

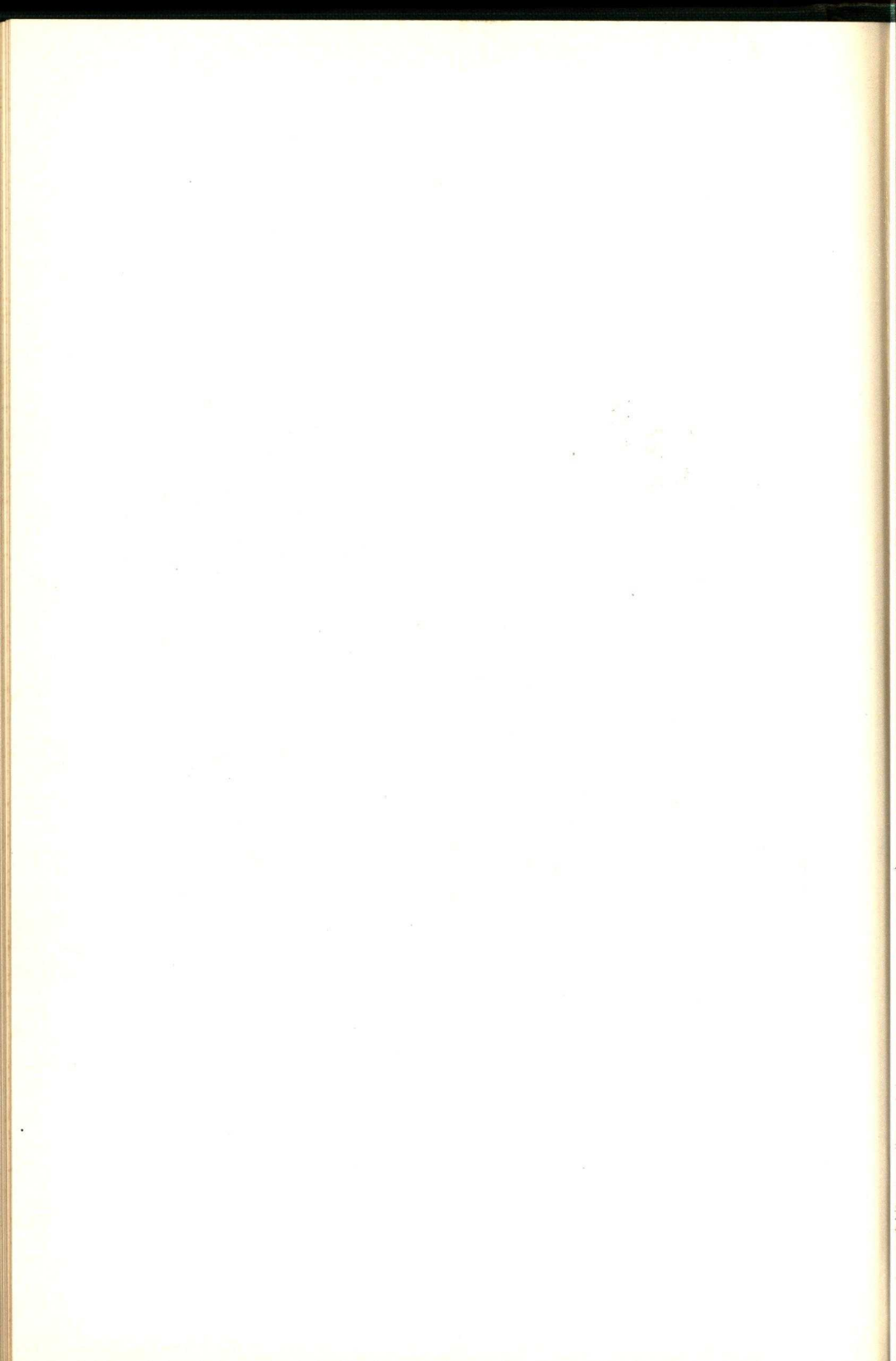
29. Molded brick are generally made with a smooth finish and are used to the best advantage with smooth-faced brick. They cannot very well be used together with the rough-textured brick that are so popular at the present day.



By courtesy of Hydraulic-Press Brick Co.

I L T 31F—1832

FIG. 29



Molded brick of rough texture are, however, sometimes made of the same color and texture as the brick used in the brick field; an example of such brick is shown in the moldings over the door and window in Fig. 49.

30. Molded Brick Cornice.—A cornice composed of molded brick, together with plain face brick, is shown in Fig. 28. As before stated, the projection of each course must be small, and the total projection cannot be so great as that of a cornice made of stone, terra cotta, or wood.

MORTAR AND MORTAR JOINTS

31. Effect of Mortar and Mortar Joints.—The mortar joint and the mortar are essential factors in the appearance of finished brickwork. In fact they are almost as important as the color and the texture of the brick in their effect upon the appearance of the wall. Where a very thin joint is used, as in Figs. 23 and 24, the principal effect is caused by the *color* of the mortar.

The color of the mortar may be in contrast with the color of the brick, as in Fig. 29, thus forming a network of contrasting color over the entire surface of the wall, or it may be similar in color to the brick itself, as in Fig. 24, in which case the wall will have a uniform, and possibly a monotonous, color effect.

The wider the joints the greater will be the effect of the color of the mortar upon the wall. In an extreme case, such as shown in Fig. 19, where the bricks used are 18 in. $\times$ 2 in. on the face and the mortar joints are 1 inch in width, the areas of the brick and the mortar showing in the face of the wall are as 2 is to 1, or, the area of the mortar in the face of the wall is one-third of the entire area of the wall. It will readily be seen that in such a case the color of the mortar would be extremely important.

32. Whether the mortar in the joints is flush with the surface of the bricks or is slightly recessed also makes a great difference in the appearance of the wall. If the mortar is kept

flush with the surface of the bricks, as shown in Figs. 18 and 19, the effect of the joint depends entirely upon the texture and color of the mortar. When, however, the joints are recessed, or *raked*, each brick casts a small shadow on the mortar joint, making a dark line below and on one side of each brick, which makes the bricks stand out separately and also emphasizes the joints, as shown in Figs. 13 and 20.

33. The mortar may have a smooth or a rough texture. In Figs. 24 and 29 the mortar shows a smooth texture, in Figs. 13 and 20 a rough texture. The rough-textured mortar has a brilliancy due to the alternation of light and shade, and is generally used with a rough-textured brick.

34. Composition of Mortar for Face Brick.—For fine joints and for smooth-faced brick, a mortar made of fine sand, cement, and lime is satisfactory; and mortar colors may be added to give the mortar the desired tone or color. This mortar, however, is unsatisfactory for a joint $\frac{1}{2}$ inch or more in width, as it is too soft and pasty and would squeeze out between the bricks while they are being laid.

Practical experience has demonstrated that, with the proper kind of mortar, brick can be laid with a wide rough joint even more rapidly than with a narrow one.

35. Materials Used for Making Mortar.—Mortar for joints over $\frac{3}{8}$ inch in width should contain a liberal proportion of fine pebbles, $\frac{1}{4}$ inch or less in diameter, known to the building trade as *grit*, in addition to coarse sand, cement, and a small amount of lime putty or hydrated lime, and coloring matter if desired.

36. Grit.—Grit consists of small pebbles $\frac{1}{4}$ inch or less in diameter, and should be screened so as to remove all sand. This material gives a characteristic texture to the mortar, as shown in the joints in Fig. 13. It also gives a body to the mortar which enables it to stand up under the brick until the cement sets.

37. Sand.—Ordinary bank or pit sand is satisfactory for dark-colored joints, but where white or light-colored mortar is required, either white sand or coarsely ground marble or limestone is used. For very fine white joints pulverized marble, called *marble dust*, is used. Sand from sea beaches is not a desirable sand to use for mortar unless it has been thoroughly washed. If it is not washed the salt is apt to appear on the face of the brickwork in the form of efflorescence.

38. Cement.—The best cement to use for all brickwork is standard Portland cement. For white mortar, however, a white Portland cement, which is made from white clay and limestone and possesses the qualifications of a standard Portland cement, is preferable.

39. Lime.—*Lime putty* adds to the whiteness of the mortar and also makes the mortar work more easily under the trowel. The lime should be well slaked and strained and allowed to stand for several days before it is used.

Hydrated lime is lime artificially slaked, and is sold in the form of a very fine powder. Under most conditions hydrated lime may be used instead of lime putty. It has the advantage that it can be used immediately, whereas lime putty requires several days for preparation.

40. Coloring Materials.—Most of the mortar colors employed to color the mortar used in laying and pointing face brickwork consist of mineral pigments, and are sold either as a dry powder or in the form of pulp or paste. The pulp colors seem to mix better with the mortar than the dry colors and are therefore preferable for the better class of work. Mortar colors, whether dry or in paste form, should never be mixed with lime until the lime has been slaked for at least 24 hours. The mortar color should in any case be thoroughly mixed with the mortar, and exactly the same amount of color used for a given quantity of mortar. If this is not done there will be variations in the color of the finished mortar joints which may not be desirable.

The color of mortar appears to be much darker when the mortar is wet than when it is dry. It is therefore advisable to mix a sample of the mortar containing a measured quantity of mortar color and try it out on a small portion of the wall. This, when dried out, will show the true color of the mortar in connection with the brick. If the first experiment is not satisfactory, other mixtures of mortar can be tried until a good color is obtained. The proper proportion of mortar color having thus been determined, all mortar that is afterwards prepared should be mixed in exactly the same proportions.

41. Suggestions for Coloring Mortar.—The following are useful suggestions as to the color of mortar to be used with different colored brick.

With brick of varying shades of *red*, a cream-gray mortar, as shown in Figs. 19 and 20, is effective. Where a darker effect is desired a dark reddish brown mortar may be used.

With *gray* brick, light-gray mortar, such as shown in Fig. 24, is good. Where a thicker joint is used, a raked joint is very effective. For a darker effect, mortar of a dark gray or a dark brown, such as shown in Fig. 29, is a good color to use.

For brick of golden or buff shades, a cream-gray or warm-gray mortar is effective.

42. Formulas for Mixing Mortar.—The following formulas for mortars are the result of careful experiments and will make excellent mortars of the colors named. The term *part* as here used refers to any unit that may be used as a measuring unit. For small batches of mortar a mason's bucket of 14 or 16 quarts capacity may be used and each bucketful considered as a part. For large quantities of mortar a tight barrel, such as a Portland cement barrel, may be used as a measure of one part. It is very important that exactly the same proportions of the ingredients be used in all the batches or else each batch will show a different color in the wall, which may be very undesirable.

One of the small batches made with a bucket as the unit, mixed according to one of the following formulas, should be enough mortar to lay 100 bricks.

FORMULA I. LIGHT-GRAY MORTAR: PARTS

Quarter-inch grit	2
Coarse sand	5
Portland cement	1
Hydrated lime	$\frac{1}{2}$

FORMULA II. CREAM-GRAY MORTAR:

Quarter-inch grit	2
Coarse sand	5
Portland cement	1
Hydrated lime	$\frac{1}{2}$
Yellow powder mortar color.....	$\frac{1}{6}$

FORMULA III. DARK-GRAY MORTAR:

Quarter-inch grit	2
Coarse sand	5
Portland cement	1
Hydrated lime	$\frac{1}{2}$
Yellow powder mortar color.....	$\frac{1}{12}$
Black paste mortar color.....	$\frac{1}{16}$

FORMULA IV. DARK-BROWN MORTAR:

Quarter-inch grit	2
Coarse sand	5
Portland cement	1
Hydrated lime	$\frac{1}{2}$
Yellow powder mortar color.....	$\frac{1}{3}$
Brown paste mortar color.....	$\frac{1}{3}$
Black paste mortar color.....	$\frac{1}{50}$

FORMULA V. LIGHT-GRAY MORTAR: (For a small batch)

Quarter-inch grit	2 buckets
Coarse sand	5 buckets
Atlas cement	1 bucket
Hydrated lime	$\frac{1}{2}$ bucket
Yellow powder mortar color.....	1 pint

43. Amount of Mortar Required.—The amount of mortar required for laying face brick will, of course, depend upon the thickness of the joint used. For joints $\frac{1}{4}$ inch to $\frac{3}{8}$ inch thick between standard-sized brick, about .4 to .6 cubic yard of mortar will be required for laying 1,000 brick. For joints

$\frac{1}{2}$ inch to $\frac{5}{8}$ inch thick about .8 to .9 cubic yard, and for joints $\frac{3}{4}$ inch to 1 inch thick about 1.2 to 1.6 cubic yards, will be needed to lay 1,000 brick. One barrel of cement and 3 barrels of sand will make about 12 cubic feet, or .44 cubic yard, of mortar.

44. Finish of Joints.—It is always best to finish the joints of the face brickwork as the work progresses rather than

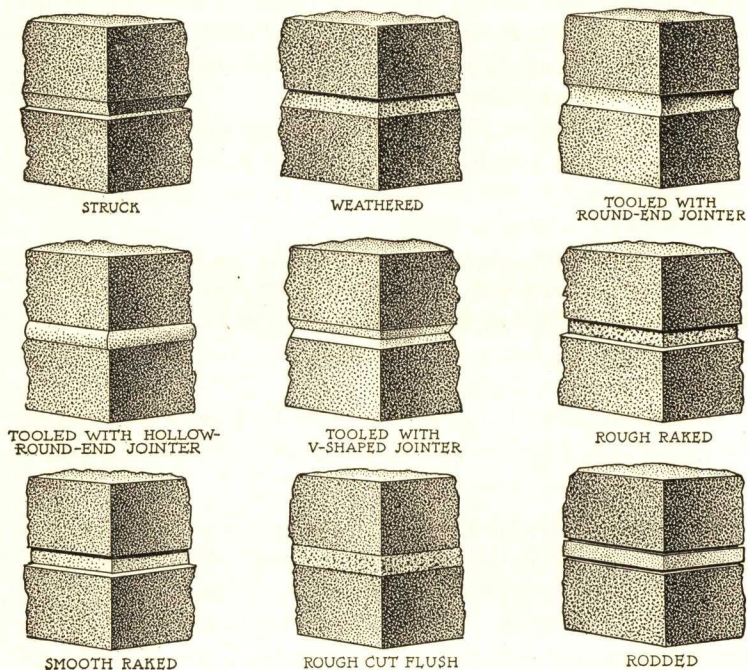


FIG. 30

to rake out the joints and point them after the wall has been built. There are several ways of finishing the joints, which have become standard, all of which have some practical or artistic merit. They are illustrated in Fig. 30.

A **struck joint** is one that is made by drawing the point of the trowel along the joint and smoothing out the mortar so that the upper edge of the joint is flush with the brick while the lower edge of the joint is slightly back of the upper edge of the lower brick.

A **weathered joint** is one made by drawing the trowel along the joint so that the mortar at the lower edge of the joint is flush with the lower brick while the mortar at the upper edge of the joint is slightly back of the lower edge of the brick above the joint.

A **tooled joint** is made with a special tool called a *jointer*, which is described later. There are three forms of the tooled joint, which are made with jointers of different shapes. These three joints are marked as tooled with round-end, hollow round-end, and **V-shaped jointers**.

A **raked joint** is formed by scratching out the mortar to a depth of from $\frac{1}{8}$ inch to $\frac{1}{2}$ inch. This is done with special tools, which will be described later. A raked joint may have a rough finish or a smooth finish.

A **rough-cut flush joint** is formed by allowing the mortar to ooze out beyond the face of the brick and cutting off the surplus with a quick stroke of the trowel just after the mortar has begun to set, but in such a manner as to avoid smoothing the surface of the mortar.

A **rodged joint** is one that is made by cutting a line along the upper and lower edges of the joint with the edge of a trowel.

45. Examples of Finish of Joints.—A *rough-cut flush joint* is illustrated in the wall shown in Fig. 19. In this example, real Roman rough-textured brick are used with a flush joint 1 inch in width. This type of brickwork is found in ancient Roman buildings.

Fig. 20 illustrates the use of a rough-textured brick and a rough raked joint. The brick are laid up in English bond. In Fig. 29, smooth-textured mottled brick of standard size are shown laid up in Flemish bond with smooth raked joints of dark-brown mortar.

46. A mortar joint that is decidedly black or white is to be avoided. The black joint has a deadening or dulling effect on the general color of the mass of brickwork, while the white mortar looks too bright and new and generally makes too sharp a contrast in color with the brick.

34 FACE AND ORNAMENTAL BRICKWORK

47. Tools Used in Finishing Joints.—The *trowel* is used to make the struck joint and the weathered joint and, in connection with a straightedge, in forming the rodded joint.

The tooled joint is made with a tool called a *jointer*, *jointing tool*, or *jointing steel*. Forms of jointers are shown in Figs. 31, 32, and 33. The jointer shown in Fig. 31 consists of a piece

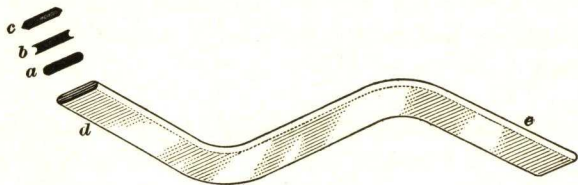


FIG. 31

of flat steel bent as shown and with the edges *d* and *e* made of different shapes so as to produce the different forms of joints. Three of these shapes are shown at *a*, *b*, and *c*. The mortar joint is finished by drawing the jointer along between the edges of the bricks and pressing it against the mortar. The jointer forms the joint according to the shape of its edge. The edge *a* makes a hollow joint, the edge *b* forms a *beaded* or projecting half-round joint, while the edge at *c* is used to form a **V**-shaped joint. These joints are shown in Fig. 30.

48. Another form of a jointing tool is one that has a circular cross-section and a tapering point, as shown in Fig. 32.

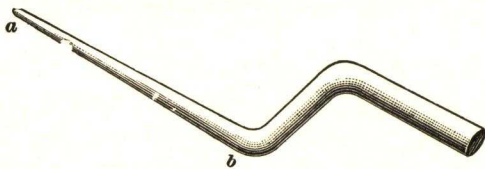


FIG. 32

The fine point at *a* is used in pointing the finer joints, and the thicker part *b* is used for coarser joints. This tool is used only for hollow joints.

A similar jointer, also circular in section, is shown in Fig. 33 (*a*). The jointer tapers so that it can be used for joints of different widths.

49. Tools for Raking Joints.—A simple device for raking the mortar out of the joints to form a raked joint is shown in Fig. 33 (b). It consists of a flat steel bar with projections on each end which are the shape of the joint to be raked. The same tool can be used for raking two different sized joints. The projection *a* or *b* is drawn along in the joint and cleans out the mortar according to its length and width. The shoulders *c* prevent the joint being scratched out beyond the desired depth.

50. A patented device for raking out and striking a raked joint is shown in Fig. 33 (c). This tool consists of a handle *a*

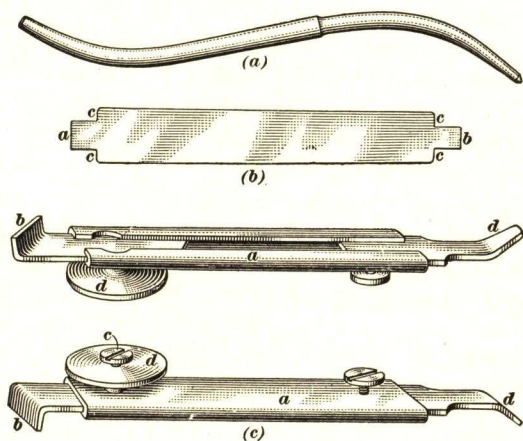


FIG. 33

into one end of which *joint scrapers*, or *plows*, *b* can be fitted. Different sizes of plows are used according to the thickness of the joints. The plow can be extended to cut any depth of joint required, and is held firmly to the handle by means of a screw bolt *c*, the head of which is shown above the wheel *d*. This wheel runs along on the face of the brick as shown in Fig. 34 at *a* and regulates the distance that the plow enters the joint. Thus, when the tool is run along the face of the wall it rakes the mortar out of the joint to the desired depth, forming a rough raked joint.

In the other end of the handle, Fig. 33 (*c*), *strikers d* of different widths can be secured. These strikers are used to smooth the raked joint, as shown in Fig. 34 at *b*, thus forming a smooth raked joint.

51. Pointing.—Pointing consists of scraping the mortar out of the joints to the depth of about $\frac{3}{4}$ inch and filling them with fresh mortar. The joints are raked out with a piece of

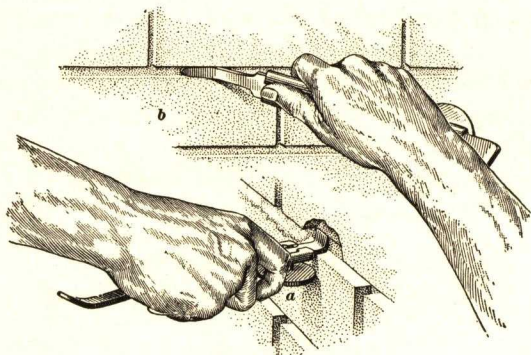


FIG. 34

wood or iron or with a tool such as has just been described. After raking, all the loose mortar should be brushed out of the joints and the joints made wet so that the pointing mortar will stick to the brickwork. The same quality of mortar should be used as for face brickwork and the joint may be finished in any of the styles shown in Fig. 30.

BOND

52. General.—The appearance of a brick surface depends not only upon the color and texture of the brick and the mortar but, to a very large extent, upon the manner in which the brick is bonded or laid in the wall.

Bonding is primarily a means of construction and is a method of tying the bricks together in such a way as to make the wall structurally solid and strong.

Face bond is the bond used on the face of the wall, and it is often independent of the structural bond of the backing.

In discussing bond or bonding in connection with face brickwork the face bond only is referred to.

53. Bonds.—There are four structural bonds that are also largely used in face brickwork. They are the *running* bond, the *Flemish* bond, the *English* bond, and the *Dutch* bond.

54. Running Bond.—The simplest bond, as far as appearance is concerned, is the *running* bond, which shows only stretchers on the face of the wall. These stretchers break joint as shown in Fig. 13. This arrangement of the bricks does not provide headers to tie the face brick to the backing, hence the tie must be provided by other means. The methods employed to tie the face brick to the backing are by means of metal ties; by clipping off the interior corners of the face brick

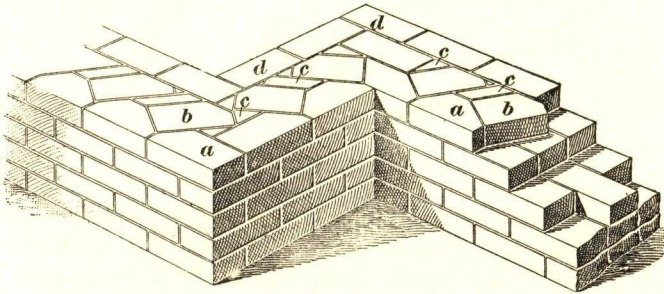


FIG. 35

and laying the interior bricks diagonally to form a bond, as shown in Fig. 35; by cutting the face brick in half lengthwise and *toothing* the backing into the space thus formed, as shown in Fig. 36.

55. Flemish Bond.—The *Flemish* bond consists of alternate headers and stretchers in each course, each header in one course being directly over the center of the stretcher in the course below. This bond is shown in Figs. 17, 18, 19, 21, 22, and 29, and is very decorative in its effect. It is particularly effective when the headers are slightly darker than the stretchers, as in Figs. 19 and 22.

A variation in this bond is illustrated in Fig. 37, where the stretcher consists of two standard-sized stretchers with a blind joint between them.

56. English Bond.—The *English* bond consists of alternate courses of headers and stretchers and is a substantial-

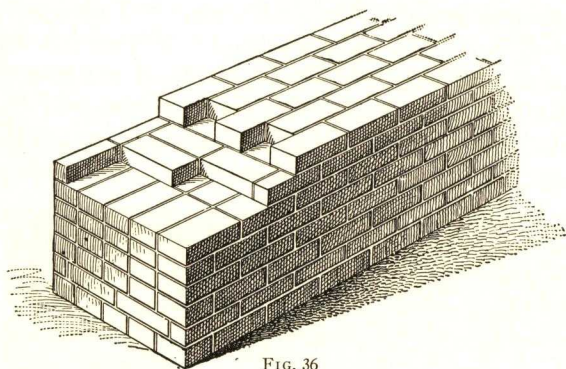


FIG. 36

looking and fine-appearing bond. It is also simple and easy to lay up.

An example of this bond is shown in Fig. 20. A great deal of the historic brickwork of England is laid in this bond and it is a very popular bond in the United States. Often, in practice,

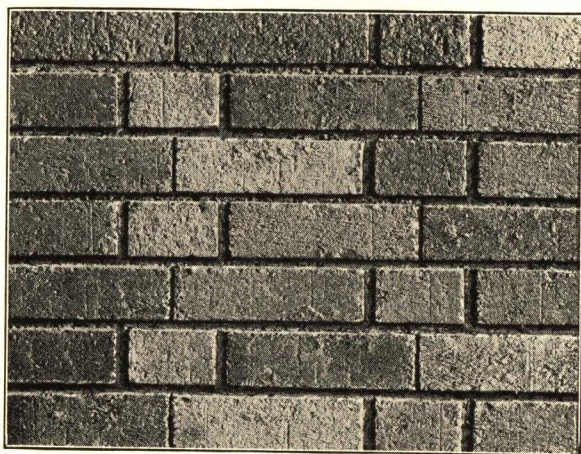


FIG. 37

only the headers of every third or fourth course in the face brick extend into the backing to form a bond or tie, or some-

times only a portion of the course extends into the backing. The stretchers in all courses are in line vertically.

57. Dutch Bond.—The *Dutch* bond is a modification of the English bond and it also consists of alternate rows of headers and stretchers. In the Dutch bond the stretchers in one course break joints with the bricks in the next stretcher course above and below, and the headers are all centered on the stretchers either above or below them. The result of this

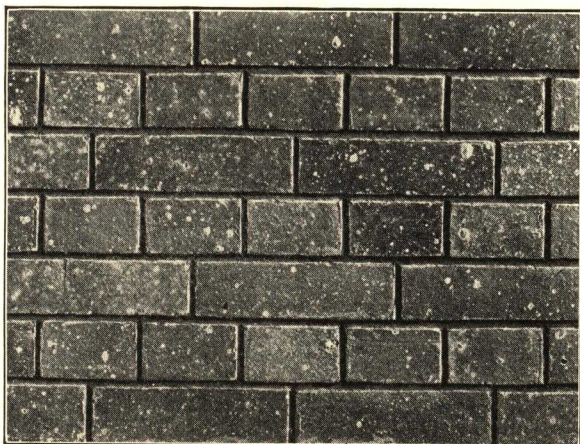


FIG. 38

arrangement is that the vertical joints form a diagonal pattern over the entire face of the wall, which has a very artistic appearance.

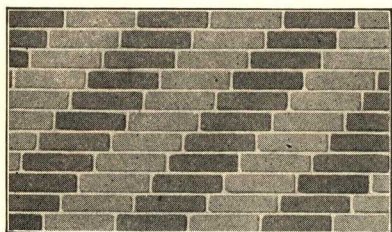
This bond is also known as the *Dutch cross bond* or the *English cross bond*, and is illustrated in Fig. 38.

58. American, or Common, Bond.—The bond called American, or common, bond is made by introducing a course of headers, called a *bond course*, every fifth or sixth course. This bond is the one generally used in building ordinary brick walls in the United States, and is also sometimes used as a face bond.

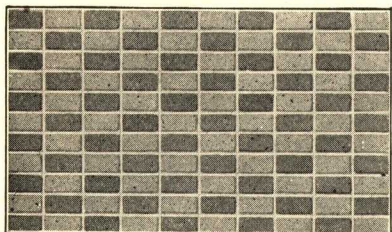
59. Miscellaneous Bonds.—Besides the bonds that have just been described, which may be considered as the

standard bonds used in brickwork, there are many other bonds, most of which are variations of these standard bonds. These more complicated bonds, however, are used merely for their

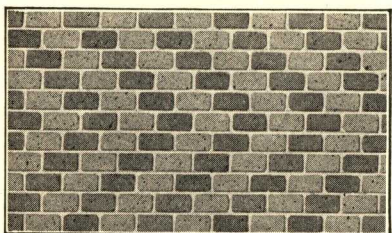
decorative effect and should properly be considered under the subject of Pattern Work.



(a)



(b)



(c)

FIG. 39

stretchers, while the patterns in (b) and (c) are formed entirely of headers. The brick in (a) must be tied to the backing as described for running bond. The brickwork in (b) and (c) can easily be tied to the backing by allowing headers to extend back into the wall as frequently as may be desired. Most of the headers shown in (b) and (c) are bats or half-bricks. These patterns may be formed by the

PATTERN WORK

60. Pattern Work on Wall Surfaces.—Pattern work is formed by arranging the bricks and joints according to some pleasing design, also by varying the color, texture, and sizes of the brick. The bonds already shown give simple and more or less pleasing patterns, and some of the more complicated bonds will next be considered.

61. Variations of the Running Bond.

Three variations of running bond are shown in Fig. 39 (a), (b), and (c). The pattern at (a) is formed of

arrangement of the joints only or by the use of bricks of different colors or textures.

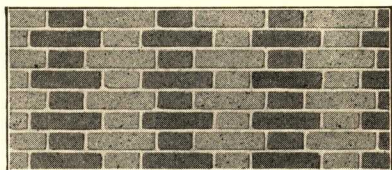
62. Variations of the Flemish Bond.—The arrangement of the joints in Flemish bond does not permit of any modification but there is a great variety of pattern work that can be produced by the use of different-colored brick. Some of these patterns are shown in Fig. 40. The pattern in (c) is the one which is very popular and is used frequently.

63. Variations of the English Bond. Variations in pattern, using English bond, are made by using bricks of different colors as shown in Fig. 41.

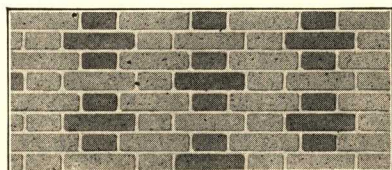
64. Variations of the Dutch Bond.—Variations in pattern in the Dutch bond can be made only by the use of different-colored bricks. Two patterns are shown in Fig. 42.

65. Miscellaneous Patterns.—There are innumerable patterns that can be made on wall surfaces by manipulating the jointing and the colors of the bricks.

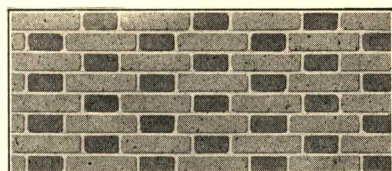
A great number of patterns are formed by using a course of stretchers alternating with a Flemish course. Several of these patterns are shown in Fig. 43. In (a) is shown a pattern that will have the effect of vertical lines of differing thickness;



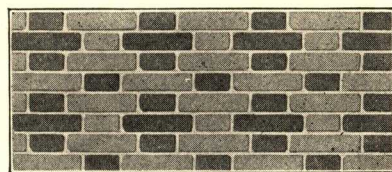
(a)



(b)



(c)



(d)

FIG. 40

at (b) is a pattern of small crosses extending over the entire field; (c) shows a pattern in which all the headers are darker in color than the stretchers.

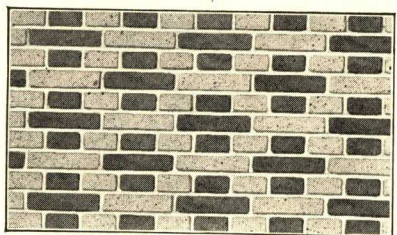
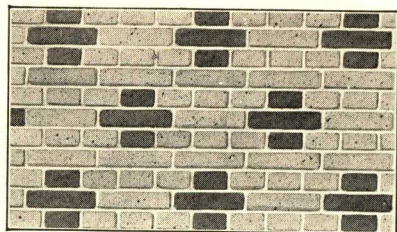


FIG. 41

The pattern shown at (d) has a diamond effect. The pattern at (e) is one that is formed largely by the joints and has a refined and artistic effect. A portion of wall laid up with this design, but without a difference in the brick coloring, is shown in Fig. 44.

In this particular example, rough-textured brick of various shades of reds,

browns, and soft purples, laid up with a cream-gray flush joint, gave the finished brick surface an artistic and decorative effect.

Other patterns are shown in Figs. 45, 46, and 47. Intricate and exceedingly interesting patterns are shown in the Persian minaret in Fig. 8.

Various designs for wall patterns will be found in the illustrations shown in this Section and the student will find it interesting and profitable to study them and determine how they are formed.

The simplest designs to execute, so far as the mason is concerned, are those in which standard-size brick are used, and in which the pattern work does not interfere with the

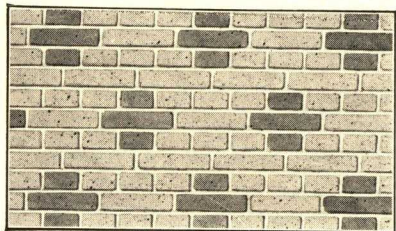
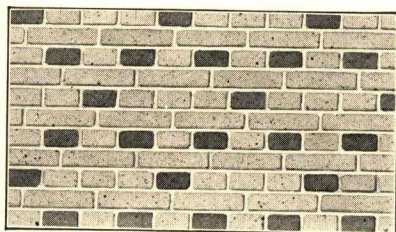


FIG. 42

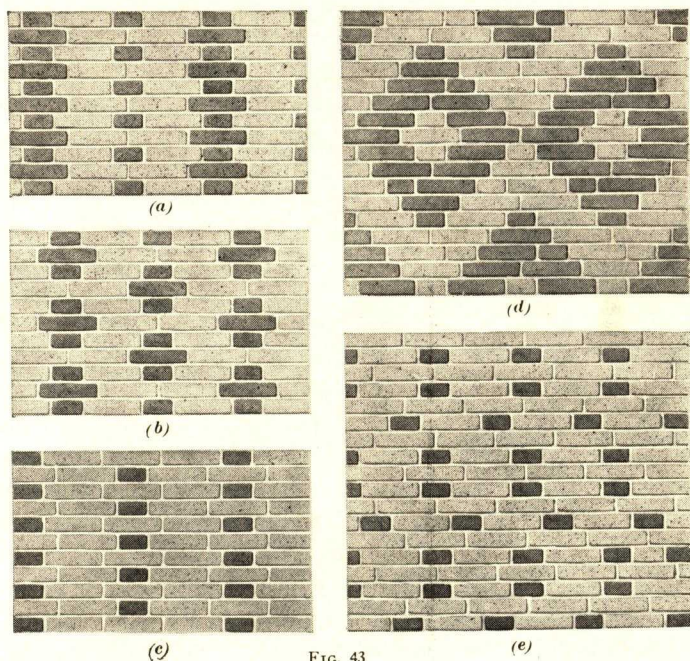


FIG. 43

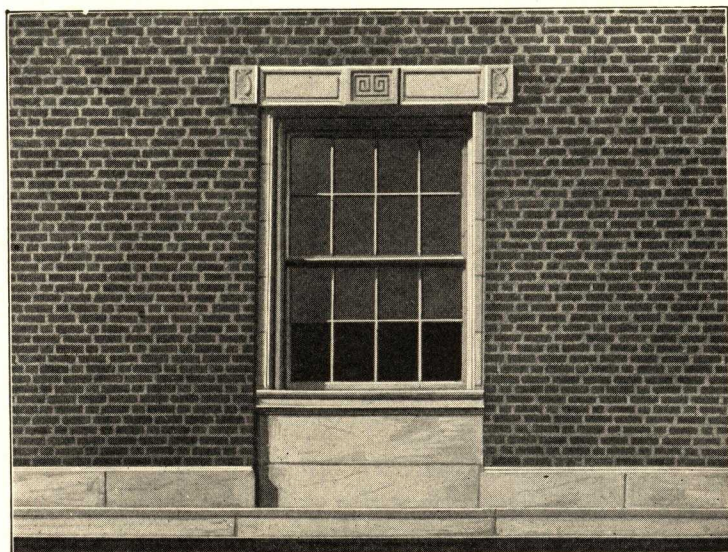


FIG. 44

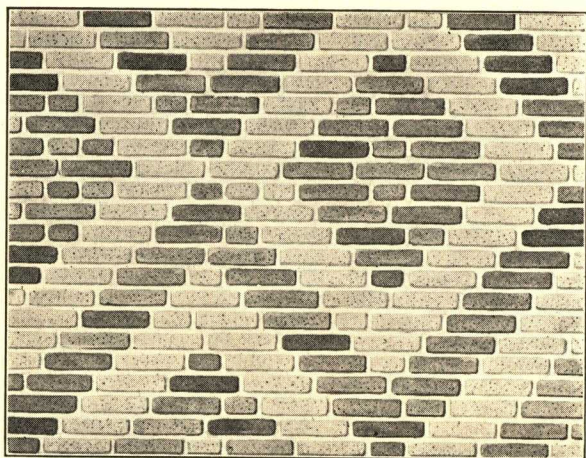


FIG. 45

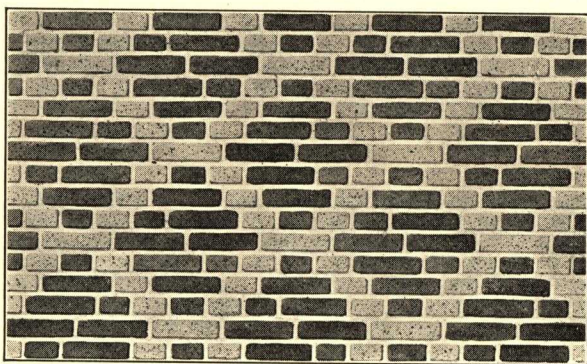


FIG. 46

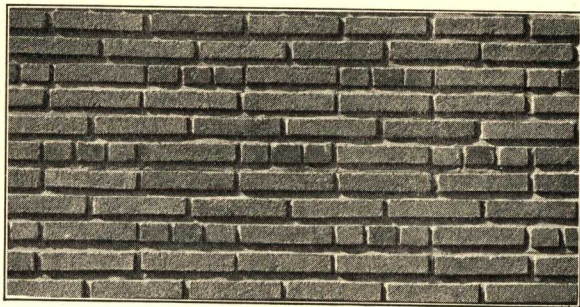


FIG. 47

particular bond used in the general field. An example of this is shown in Fig. 48.

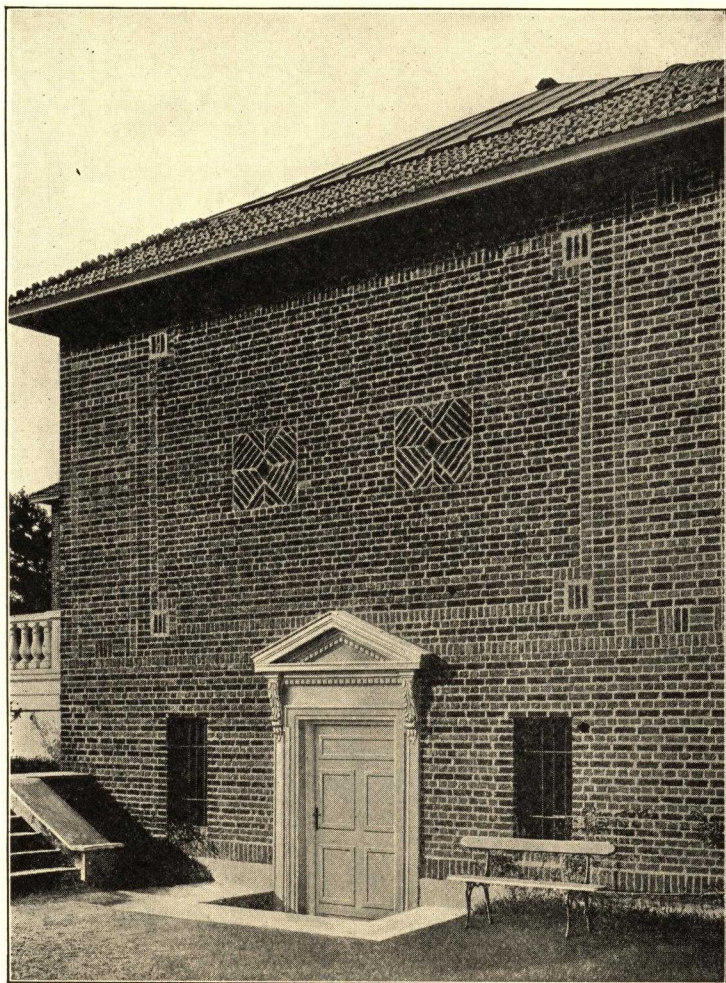
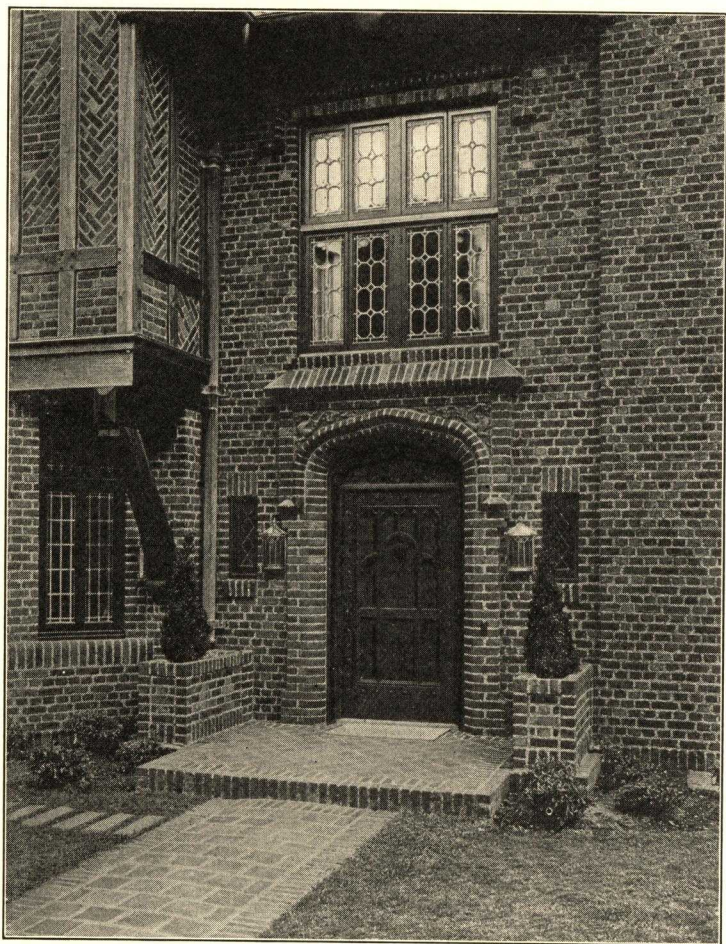


FIG. 48

66. When diagonal patterns such as shown in Figs. 43, 44, 45, and 46 are used, care should be taken in designing the façade so that the pattern will have a proper relation to the

openings and corners of the wall. Thus, the pattern should meet both sides of a window symmetrically, as shown in



By courtesy of Fiske & Co., Inc.

FIG. 49

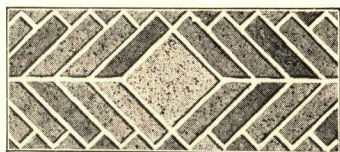
Fig. 44, and make a neat finish at the corner of a wall, as shown in Fig. 49.

67. Herring-Bone Pattern.—A pattern known as the *herring-bone* pattern, which is very much used in paneling, is

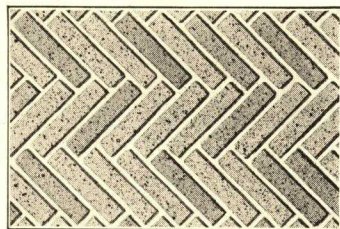
illustrated in Fig. 50. Designs such as shown in (a) are adaptable to running bands or friezes. The designs in (b) and (c) are useful for panels. These patterns, particularly (b) and (c), are also very much used in floors made of brick or tiles.

68. Friezes and Bands.—As a rule, it is best to keep the patterns used in large brick fields rather quiet and subdued and to emphasize some band or frieze or some particular spot by a more interesting and elaborate treatment. The plainness of the field will then set off to advantage the more complicated design of the frieze or spot, and produce a more satisfactory result. This method of treatment is illustrated in Figs. 51, 58, and 63, where ornamental bands are used in connection with plain fields, also in Fig. 1, where a plain field in Flemish bond is surmounted by handsome friezes or bands of patterned work which crown the wall. Fig. 51 illustrates the effectiveness of ornate bands or friezes over a plain wall.

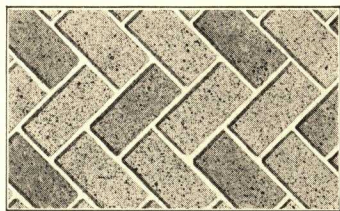
69. Designs for bands in face brickwork are given in Figs. 52, 53, and 54. Fig. 52 shows a *chain pattern* formed in Flemish bond, Fig. 53 is a *chain pattern* in English bond, and Fig. 54 is a more complicated pattern showing the use of special-sized brick, which have already been described. These effects are produced by differences in the color of the brick as well as by the bonding. Other designs for bands are shown in Figs. 1, 64, and 65.



(a)



(b)



(c)

FIG. 50

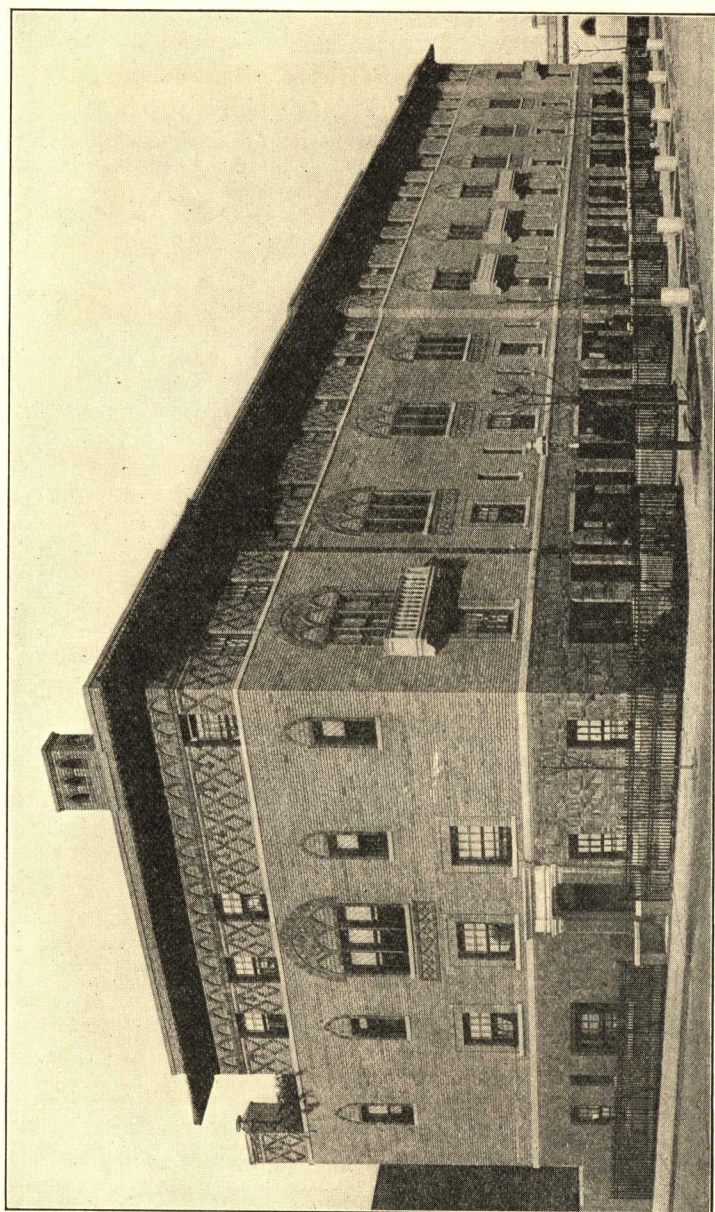


Fig. 51

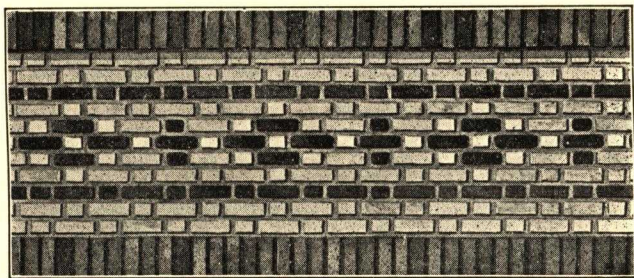


FIG. 52

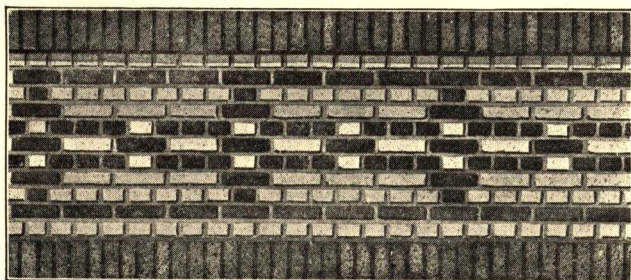


FIG. 53

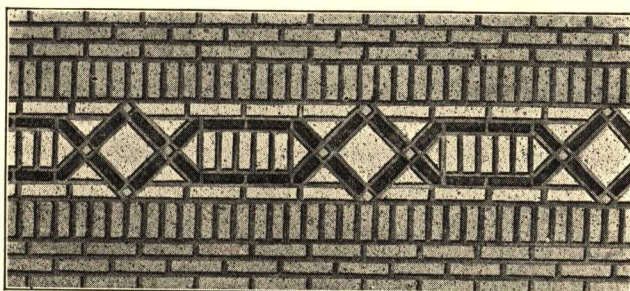


FIG. 54

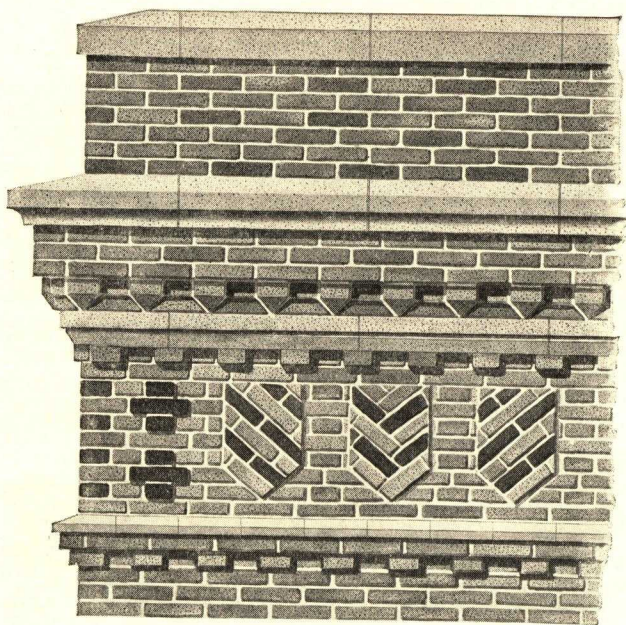


FIG. 55

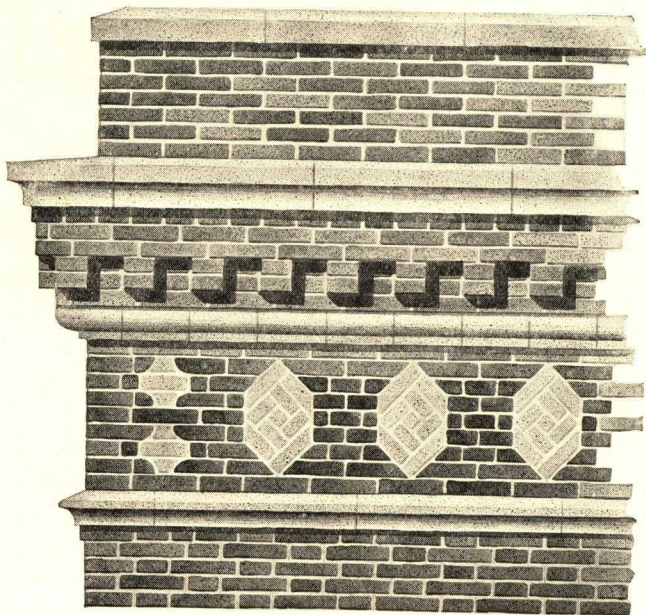


FIG. 56

Friezes containing special designs made of brick cut to various shapes and representing shields, hexagons, etc. are illustrated in Figs. 55 and 56.

70. Borders.—Borders are used around large panels such as frequently occur on school buildings, theaters, and factory buildings, which, if not especially treated, would appear uninteresting. Fig. 48 suggests a treatment of a large panel and border in a brick building which makes it interesting without using special brick and at very little expense more than would be incurred in making a plain wall.

A design for a border is shown in Fig. 57 in which the bands *a*, *a* as well as the corner pieces *b* are raised above the field about $\frac{1}{2}$ inch. The headers may be black headers where so indicated or else brick of a slightly darker color than the rest. The pieces *b*, *c*, and *d* may be tiles or bricks of special shape and different color from the brickwork of the field. A handsome border, used around a panel on an interior wall, is shown in Fig. 58.

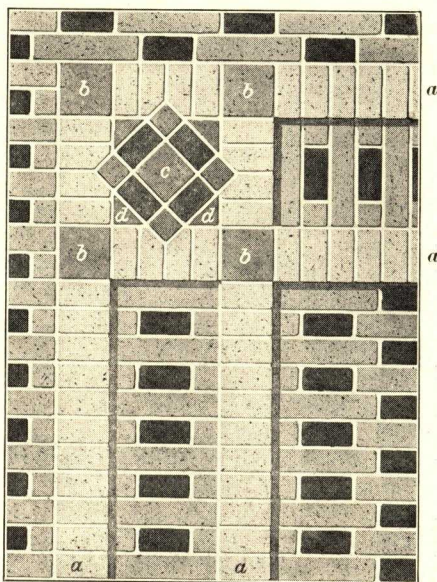


FIG. 57

71. Panels.—Panels are shown in Figs. 48, 58, 59, and 60. In Fig. 48, a large panel is formed by a border of headers and rowlocks, with the corners emphasized by bricks set on end, in soldier courses. Two points or spots in the field of this panel are brought out by special patterns. This wall is an example of a wall laid in English bond where the stretchers are darker

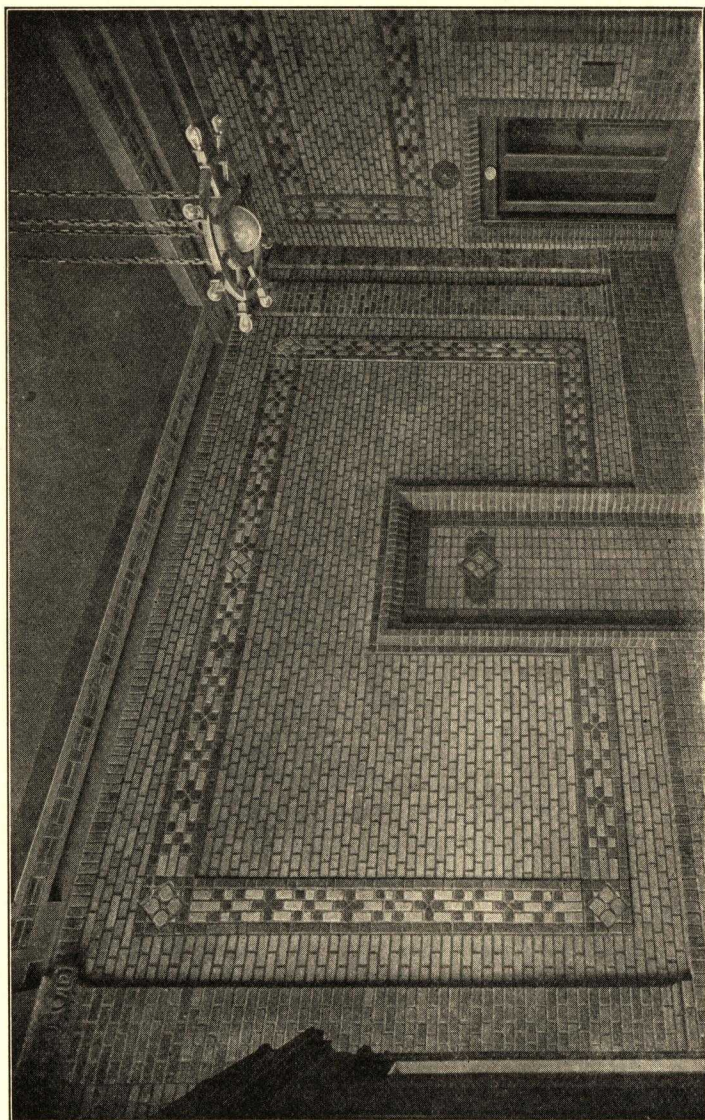


FIG. 58

By courtesy of Fiske & Co., Inc.

than the headers. The entire wall has a distinctly interesting brick character.

Fig. 58 illustrates a plain brick panel surrounded by an interesting border.

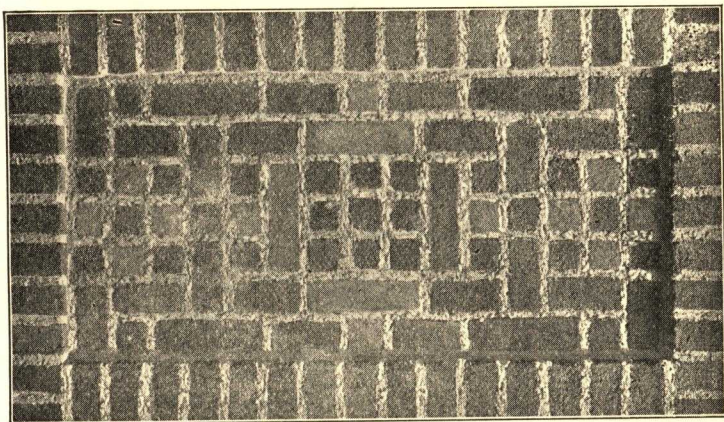


FIG. 59

The panel in Fig. 59 is an excellent example of modern brickwork in imitation of the ancient Persian work. There

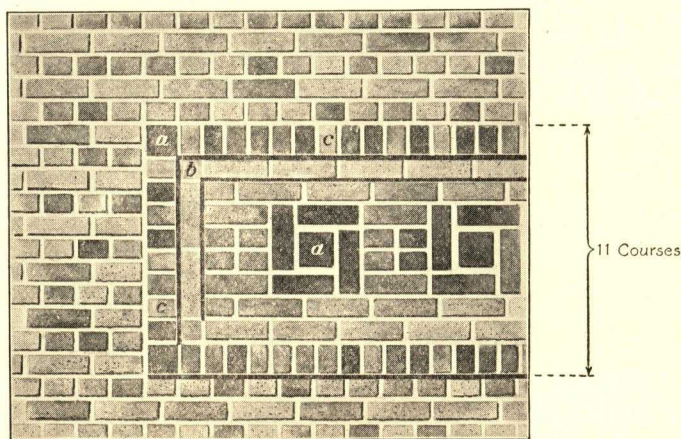


FIG. 60

are three sizes of units used in this design. The standard-size stretcher, 8 in. $\times$ 2 $\frac{1}{4}$ in., is one unit, a second is 5 in. $\times$ 2 $\frac{1}{4}$ in., and

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the third is $2\frac{1}{4}$ in. $\times$ $2\frac{1}{4}$ in. The joint used in this design is $\frac{5}{8}$ inch thick, so that three rowlock bricks in the border and two joints equal one stretcher, two of the rowlocks plus one joint equal the 5-inch unit, and one rowlock equals the third

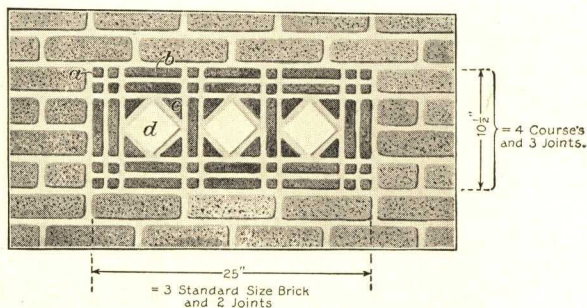


FIG. 61

unit. This combination of units lends itself to many handsome patterns. An application of this kind of panel work is shown below the frieze in Fig. 1.

Fig. 60 illustrates a simple panel design in which the border *c* has been projected slightly beyond the face of the wall. The pieces *a* and *b* are special sizes of brick made for this pattern.

The panels shown in Figs. 61 and 62 depend upon the proper selection of colors in the bricks and upon the contrast in color between the mortar and the brick. In Fig. 61 small dice 1 inch

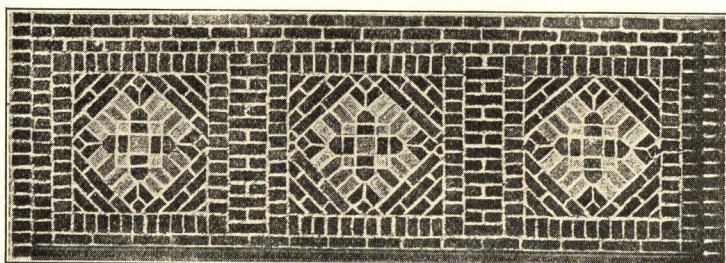


FIG. 62

square are shown at *a*, pony size brick at *b*, triangular cuts at *c*, and square tile or brick at *d*.

The application of panels to the decoration of a building is shown in Fig. 63 immediately beneath the cornice, between the

uppermost windows, and in the frieze at the top of the bay windows.

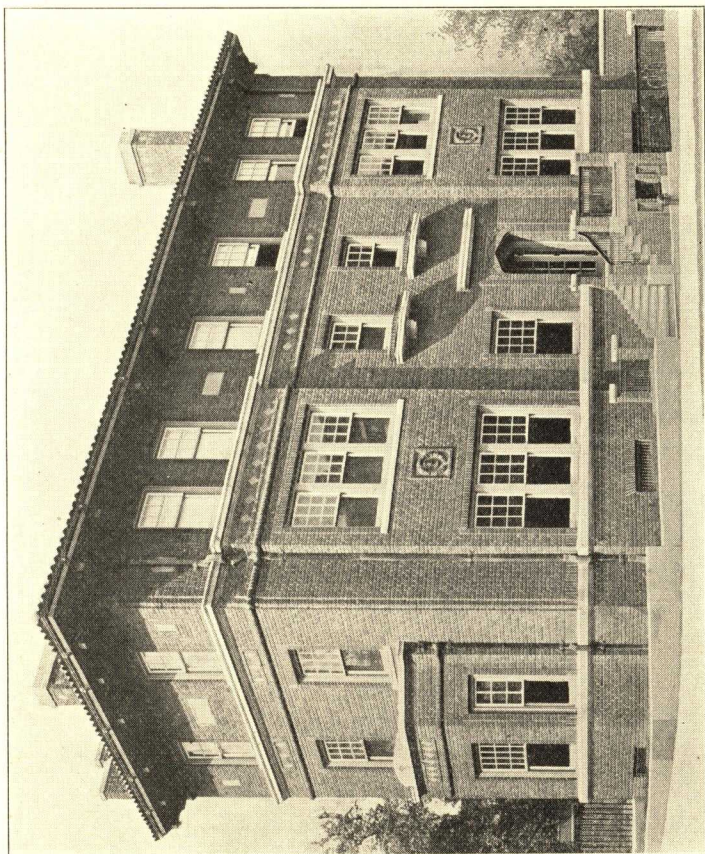


FIG. 63

72. Interior Walls.—With the great variety of color and texture found in modern brick, interior walls can be designed that are very suitable for vestibules, conservatories,

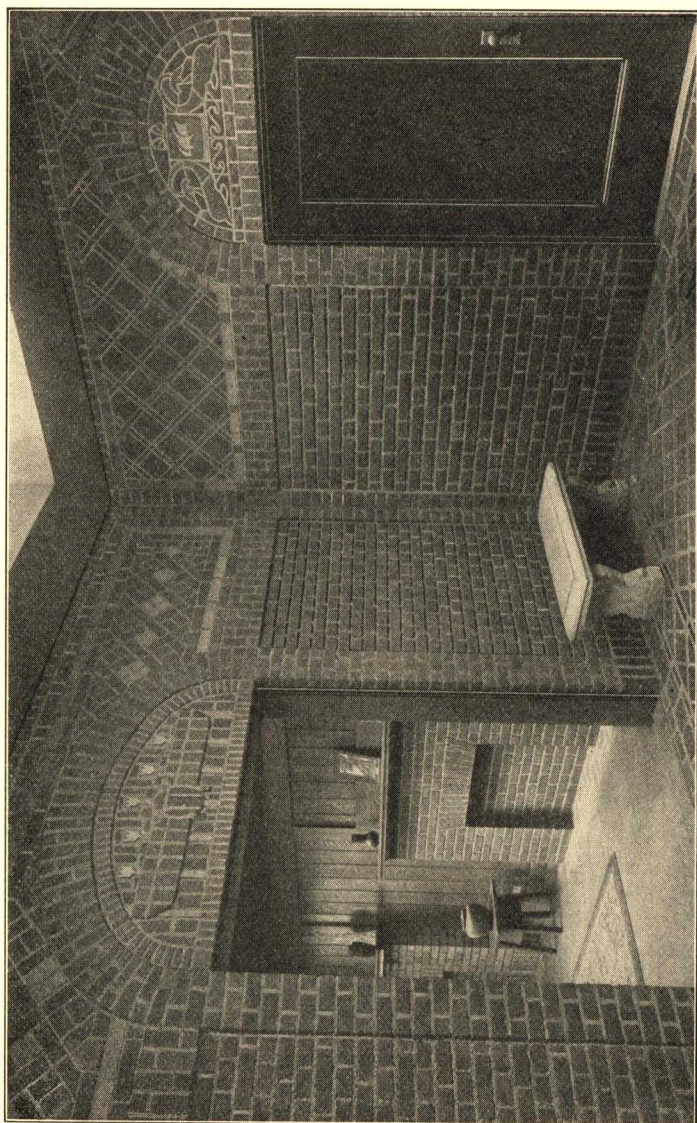


FIG. 64

By courtesy of Fiske & Co., Inc.

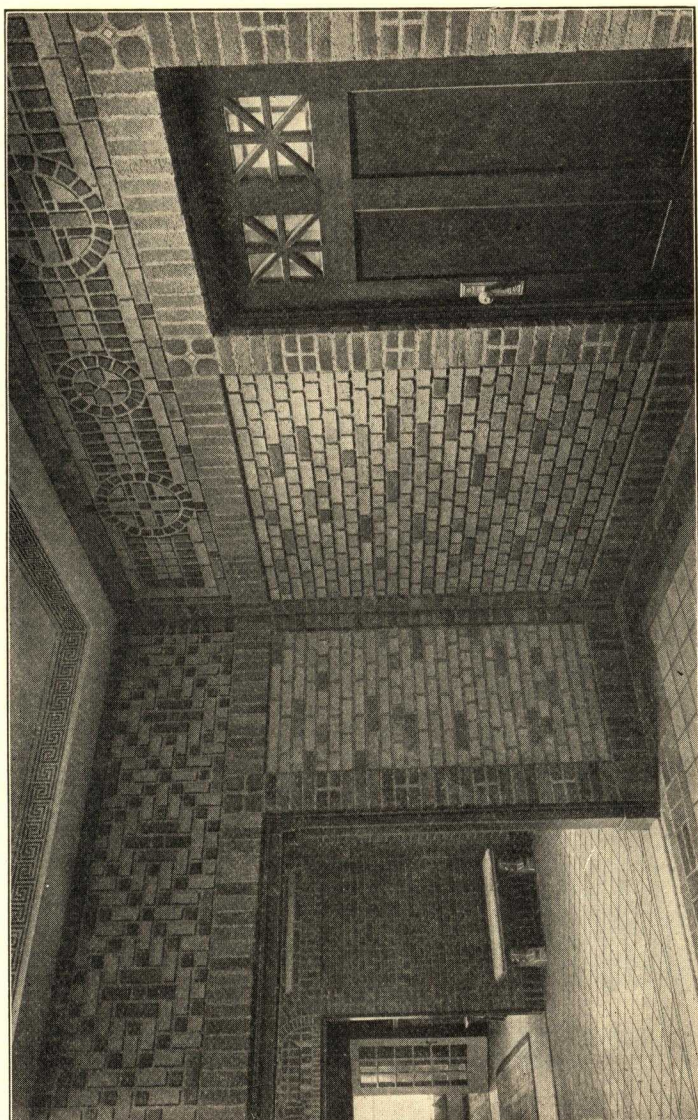


FIG. 65

By courtesy of Fiske & Co., Inc.

cafés, etc. Fig. 58 illustrates the use of brick in the main entrance lobby of a large business building, in which many of

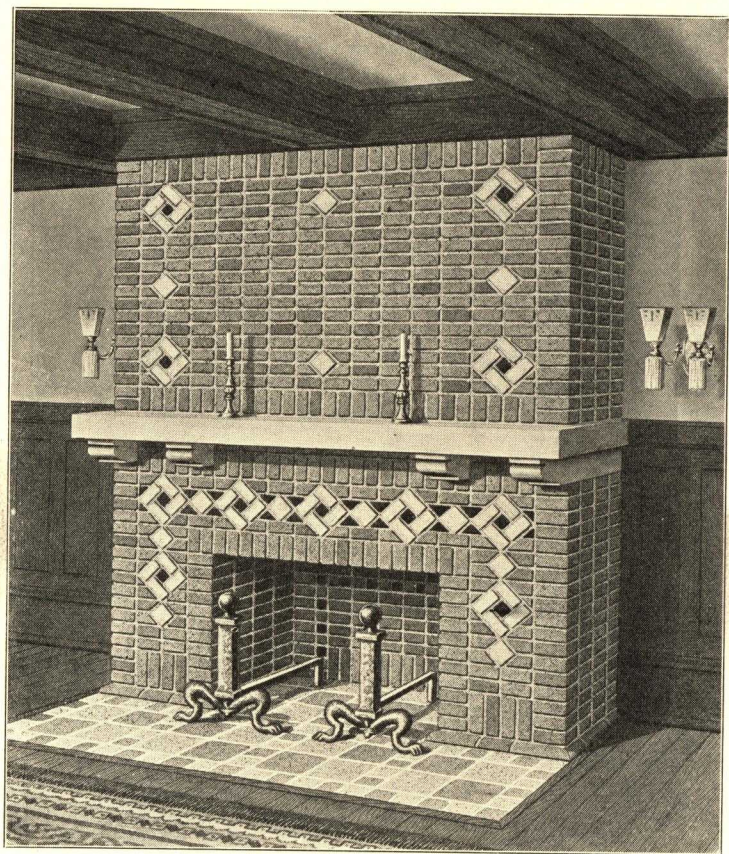
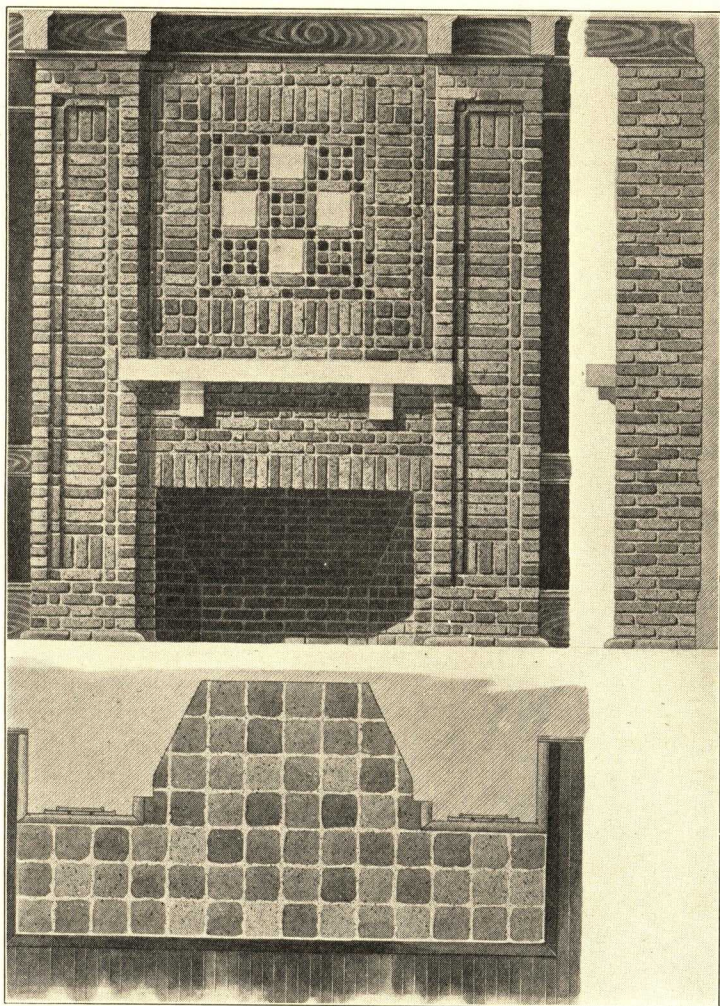


FIG. 66

the resources of face brickwork are exhibited. A soldier course occurs at the base of the wall, above which is shown a running bond of headers and a rowlock course. These form



a wainscot effect. Above this the wall is paneled, the panel being surrounded by a handsome border. The field of the panel is in Dutch bond. The trim or finish of the door openings is formed of molded brick similar in character to that of the other brick in the wall.

Figs. 64 and 65 show the treatment of walls in face brick as used in the display rooms of a prominent brick manufacturer. These walls show a variety of friezes and bonds, the use of soldier courses, friezes, bands, panels, etc. They also illustrate the use of Flemish, English, and Dutch bonds in the field, and the various special shapes of brick. Tile inserts showing dolphins and a ship are used over one doorway in Fig. 64 and an ornamented brick panel is shown over the other doorway.

73. Fireplaces.—Face brick are frequently used with artistic effect in the construction of fireplaces and chimney breasts. Figs. 66 and 67 are examples of such fireplaces. By the proper selection of colors and sizes of brick these fireplaces make very effective and ornamental features for sun parlors, living rooms, dens, and libraries.

ORNAMENTAL BRICKWORK

74. As has been stated, **ornamental brickwork** may be formed of plain brick which is built so as to project and form cornices, string-courses, and other ornamental features, or by the use of bricks which are molded into special shapes before baking.

An example of plain bricks used in forming a cornice is given in Fig. 68 in which an approximation to a classical cornice has been built as far as can be done with brick. The bottom of the cornice begins with a rowlock, or bull-header, course. Most of the projections are necessarily slight. The bold projection in the upper part of the cornice is made with especially large bricks or units which support the crowning member. A band course at the middle of this cornice is formed by building the bricks in a diagonal position so that the corners project.

This causes a variation of light and shade on the different surfaces and a wavy effect in the mortar joints. This cornice is crowned by a terra-cotta molding course. Just below the cornice are seen three tiles inserted in the brick field.

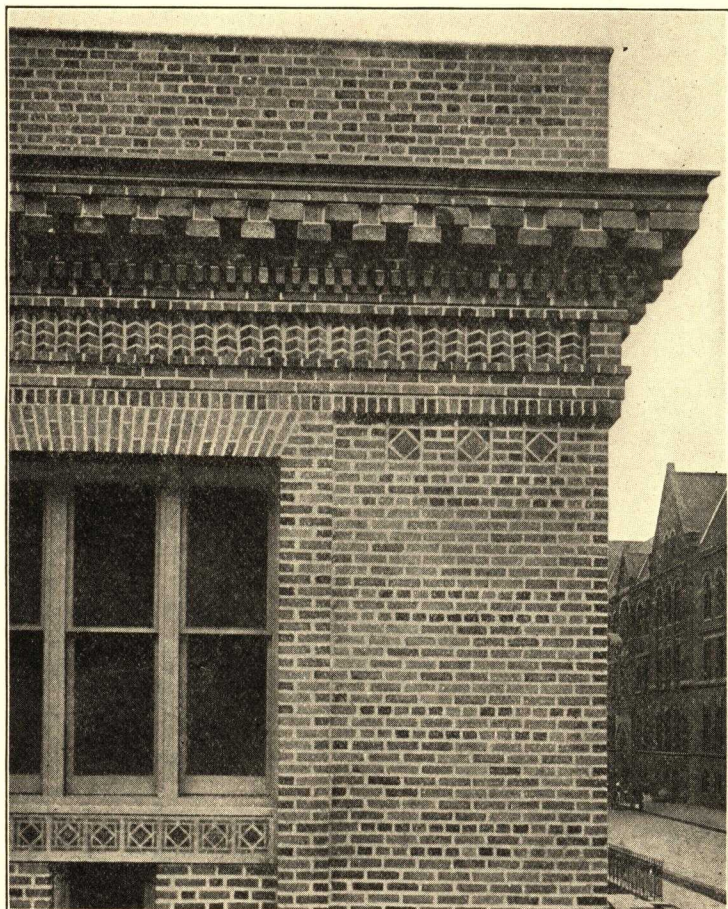


FIG. 68

Another example of ornamental brickwork formed of projecting bricks is given in Fig. 69. In this figure the outer ring of the arch is a rowlock arch and inside of this arch is a dentil

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course, so called from its resemblance to a row of teeth. The string-course above the doorway is supported upon brackets

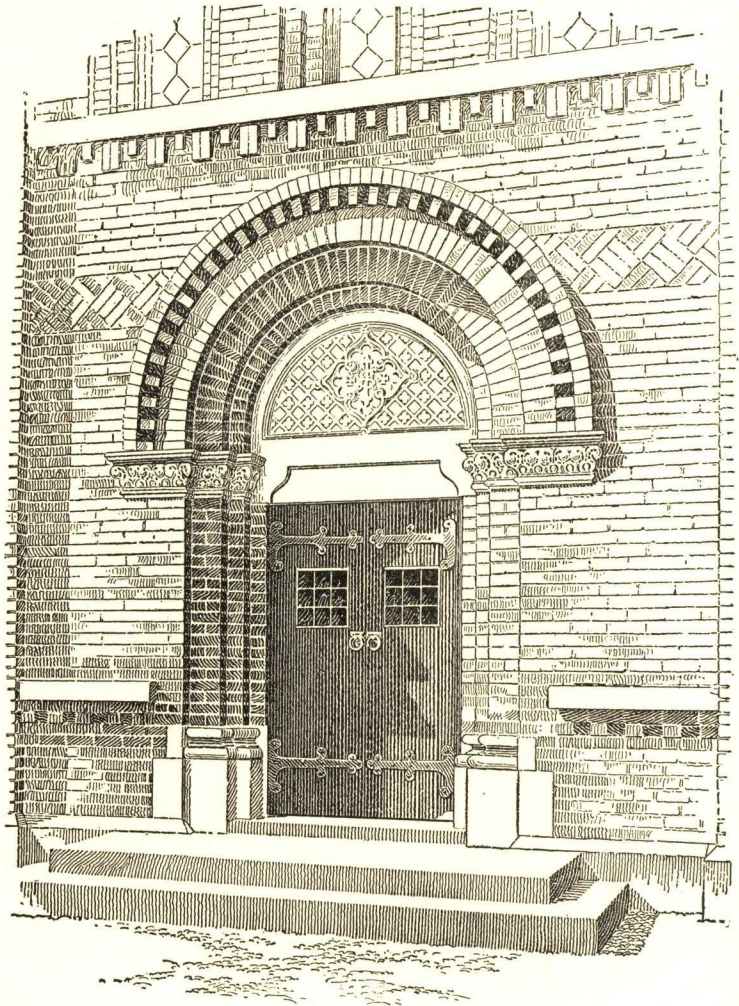


FIG. 69

formed of bricks placed on end alternating with bull headers.

Figs. 6 and 7 show examples of Italian ornamental brickwork of the 13th and 14th centuries.

